

# Aviation Week & Space Technology

April 8, 1963

SPECIAL REPORT:

## Space Vehicle Launch Facilities

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Capsules in Production

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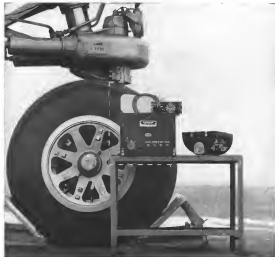


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## Here is the latest GPL navigation "first."

...Smallest, lightest Doppler Radar System  
ever produced, it's the U.S. Navy's  
choice for new ASW and attack aircraft

Out of GPL's 30 years' experience in building air navigation systems comes the AN/APN-155(V) Doppler radar system. Weighing only 40 pounds and requiring only one cubic foot of space, it's the lightest, most compact radar yet developed... and the latest in GPL's record of navigation "firsts."

Designated by the U.S. Navy as AN/APN-155(V) for use in new ASW, attack and weather aircraft, it's capable of full operation within 45 seconds, provides automatic acquisition in less than 20 seconds, operates anywhere in any weather, 0 to 70,000 ft., retains high accuracy throughout virtually all aircraft attitudes. It's easy to install... operate... maintain. Components can be interchanged without modification. AN/APN-155(V) (Model GPL-1000) represents a refinement of design techniques proved in more than 3000 radar systems built that use by GPL. It is

applicable to light commercial as well as military aircraft.

- "OTHER GPL NAVIGATION "FIRSTS"**
- ☐ Developed first direct reading ground speed and drift angle indicator
  - ☐ Produced first completely automatic global navigator
  - ☐ Produced first automatic polar mode computer
  - ☐ Produced first operational Doppler navigation equipment
  - ☐ Developed first Doppler for use in inertial system
  - ☐ Produced first track navigation computer

For information, contact GPL Division, Dept. DPA, General Precision, Inc., Framingham, New York.

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3 check valves ... 1 system relief valve. Every component is designed so it can not be assembled in other than its correct orientation. This Modular Filter-Valve Manifold provides: higher reliability, simplified maintenance, reduced weight, error-free installation, easier inspection, reduced cost and improved accessibility. Numerous fittings were eliminated, and leakage points reduced by 60% compared with the previous installation.

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## AEROSPACE CALENDAR

(Continued from p. 7)

polymers. Space Technology 11th/12th Non-joint Institute Study Week

May 9-10—Quarterly Regional Meeting of Local Transport Airbus Ltd. Week-Ten

May 14-16—National Aerospace Electronics Conference, IEEE/AAA, Dayton, Ohio

May 15-16—French Annual Symposium on High Speed Testing, United Aircraft Division, Mass. Sponsor: Fiat Tech Support Group

May 15-17—Characterization General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.

May 18-22—National Symposium on Materials Theory and Techniques, Institute of Electrical and Electronics Engineers, Mountain Hotel, Summit, N. H.

May 20-22—National Teleworking Conference, Hilton Hotel, Albuquerque, N. M.

May 23-24—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.

May 24-25—Symposium, Characteristics of the Lunar Surface, Boston Area, sponsored by Air Force Cambridge Research Laboratories, Arlington Hall, Va.

May 24-25—25th Annual Meeting and Space Conference, AIAA/ASAS, Wynton Arms, Arlington Hall, Dallas, Tex.

May 25-26—Sixteenth National Conference on Product Engineering & Production, Institute of Electrical and Electronics Engineers, Connecticut Hotel, Groton, Conn.

June 1-2—Symposium on Materials and Processes for Space, Power and Pressure Applications, Society of Automotive Material and Process Engineers, Ballroom, Sheraton Grand Philadelphia, Pa.

June 3-10—COSMOS, French International Space Science Symposium and South African Meeting, Geneva, Poland

June 6-7—Symposium on the Technology of Vents, Denver Hilton Hotel, Denver, Colo. Sponsor: American Astronautical Society, Corporate Aerospace Science Research Society, American Institute of Biological Sciences, MAA, Radio Mass, The American NAA

June 7-8—19th National Measurements & Operations Meeting, Bessing Aviation School, Reading, Pa.

June 7-10—27th French International Air Show, Le Bourget, Paris, France

June 11-16—Symposium on Plasma Space Science, The Grubbs Convention of American Universities D. C. with the support of NASA and Goddard Space Flight Center

June 12-14—Hot Transfer and Plant Mechanisms Institute, American Institute of Aeronautics and Astronautics, California Institute of Technology, Pasadena

June 17-18—Sixteenth Visiting Scientists Institute of Aeronautics and Astronautics (IAA), Hotel Ambassador, Los Angeles, Calif.

June 18-21—Symposium General Meeting in status of Electrical and Electronic Engineering, Toronto, Canada

June 25-26—Second Annual Design & Development South Hotel, Orlando, Florida, Fla.

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a pipeline to the moon



chances are somewhere along the way

you'd use Janitrol cryogenic

and pneumatic valves



heat exchangers



and couplings. Many fine



engineering organizations already do!

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Formed in one press operation using Cameron's 30,000 ton press and advanced forging techniques, these missile cases are extruded to 6" wall thickness. Cameron's new press makes possible the forging of Titanium with the minimum input weight to produce forgings of these sizes and shapes. Metallurgical data obtained from production experience of several hundred cases proves superior physical properties, including notch tensile values in excess of unity, can be consistently obtained.

Cameron is producing many other complex forgings meeting the exacting requirements of aircraft, jet engines, marine and nuclear applications. If you require high quality components—whether of carbon steel, stainless or high alloy steels, refractory or exotic metals—we invite you to investigate the advantages of having them forged by Cameron.

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## What do these 49 computers have in common?

They can "listen" and "speak" with punched tape (or electrical signals) from Teletype equipment. This means that Teletype equipment and tape-to-tape systems—connected by existing communications channels—get a centralized computer at the disposal of the most remote operation. Teletype equipment is available in a variety of code levels, with speeds ranging up to 1080 bits per second.

For additional information on how Teletype equipment can add your message and data communications planning, contact Teletype Corporation, Dept. 620, 1008 Tenby Avenue, Skokie, Illinois.



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## Chromallized turbine vanes help Pratt & Whitney Aircraft engines attain excellent performance and long life.

*Rechromallizing saves airlines substantial sums by  
reducing vane replacement costs*



Chromallized cobalt-base super alloy vanes direct the hot gas stream into the first stage turbine of Pratt & Whitney Aircraft JT-4 engines for spreads of 3846 hours at high turbine inlet temperatures.

Chromallizing, a protective alloy surfacing process, guards superalloy turbine parts against oxidation, intergranular attack and loss of strength due to alloy depletion. Materials which otherwise would deteriorate prematurely, now withstand the effects of high temperatures for longer periods of time. Over a million Chromallized vanes have proved their reliability in service on the JT-4 and other Pratt & Whitney Aircraft engines.

But better performance is only part of the story — during engine overhaul, vanes can be recoated for less than one-fourth their replacement cost. Cost reductions realized by the major airlines using this approved procedure are substantial.

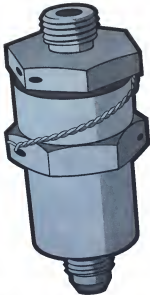
Briefly, Chromallizing is a pack cementation process in which alloying elements are diffused uniformly into a metal surface forming an integral alloy case that is highly resistant to oxidation, corrosion and wear. Depth of the alloy case can be controlled. And there is little or no dimensional change as a result of the process. Composition of the surface coating can be varied for iron, nickel, cobalt-base superalloys to meet service requirements.

In addition to turbine vanes, similar high temperature parts such as turbine blades, combustion chambers, burner tubes, etc., can be protected by Chromallizing. For more detailed information write for a free copy of CHROMALLIZING OF SUPER ALLOYS.



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## How Titanium lops pounds off VTOL Hummingbird

### -Shakes off 600' Heat -Saves precious time

Like the hummingbird for which it was named, Lockheed Georgia's XV-4A (VTOL) is designed to take off straight up, land straight down, hover in mid-air and streak forward at jet speed. Lockheed engineers say their job was made easier by the use of titanium on critical components.

**Strength in a hot spot.** Two titanium wing spars, mounted forward and rear, give support to two jet thrust engines and a 25' 8" wing span. Exceptionally high strength-to-weight ratio wasn't the only reason for specifying titanium. Exhaust gases at 1300°F are directed from the engines into a mixing chamber housed in the fuselage. Although a lot of this heat is contained, and some of it is dissipated, the outer portion of the wing spars are exposed to 300-600°F temperatures.

A high-strength steel structure would have imposed a severe weight handicap

on a plane whose bid to shed every superfluous ounce to achieve optimum performance.

**Cost production time.** The fact that titanium alloy Ti-6Al-4V could be used in its mill-annealed condition (static strength of 130,150 ksi) and process time is a tight schedule. All alloys of steel would have had to be heat treated to meet weight and strength requirements. This would have involved time-consuming machining and correcting the inevitable warping consequent to processing. Machining the spars, a difficult operation as it was, could not have been done on fully-treated steel.

Titanium was selected for other vital components, including the main landing gear tracks which carries the landing load into the plane's structure. Two skids on the landing skis are too hot for aluminum, and outer wing attack brackets.

Here is where the Ti-6Al-4V titanium alloy has saved critical weight on the Hummingbird: (1) forward wing spar; (2) main landing gear titanium links heated to 150 ksi UTS; (3) outer wing attack brackets, heat treated to 160 ksi UTS; (4) ejector seat rail; (5) aft wing spar.

Titanium's unique properties—light weight, great strength, resistance to heat and corrosion, its properties from minus 423°F to plus 1600°F, its weldability and versatility—are daily facts of life in military and industrial metallurgy. Titanium can take your weight problem, too.

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Higher and higher recording speeds, mass instrumentation progress—and problems! Increased speed and tension on tape generates friction that concentrates heat around recording heads and can make ordinary tape unreliable. Signal dropout or distortion can result when this local hot, high-temperature build-up separates recording oxides from tape backing.

"SCOTCH" BRAND Heavy Duty Instrumentation Tapes carry signals coolly through head-hot environments. They withstand temperatures from -40°F up to +250°F. They last at least 15 times longer than ordinary tapes. Their heavy duty oxides and headers are formulated to resist heat extremes, numerous ruboff. Exclusive Scotch lubrication eases head wear, tape wear. They offer 1000 times more produc-

tivity than ordinary tapes to delay all data-gathering while

16 different "SCOTCH" Heavy Duty Tapes are available in 3 series. Polyester backings offered are .65, 1 and 1.5 mils. Choice of coating thickness includes .18 and .43 mils. "400" series: excellent high and low frequency resolution. "1100" series: smooth, sharp resolution for broad band, other high frequency uses. "500" series: ultra-smooth surfaces for professional recording systems, critical wide band needs.

TECHNICAL TALK Bulletin No. 3 explains temperature effects on recording tapes, discusses heavy duty oxide and header construction. Free. Just write 3M Magnetic Products Division, Dept. MCI-43, St. Paul 19, Minn.

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ACTIVE IN THE AIR, THE ECM OFFICER USES THE SKP-4000 TO GUARANTY THE AIRCRAFT'S SURVIVAL BY DETECTING AND ELIMINATING THREATS.

## ECM officer with problems!

This electronic warfare officer is "flying" a tough mission: order jamming—shift frequency—counter jamming—canceling chaff—changing course. The ECM officer's relentless enemy helps punched cards and magnetic tape. When he stops out of the SKP simulator, his instructor will have a complete and scored report on his performance.

The SK-4 Electronic Countermeasures

Simulator was designed, developed and manufactured for SAC by Reflectone Electronics, Inc., a subsidiary of Universal Match Corporation. T-4 provides an exact replica of the SK-4's operational ECM section. Because the system can simulate virtually any RF environment encountered over any terrain, it can be adapted for training on other current or projected aircraft.

Reflectone offers an unusual capability in tactical and strategic training systems. T-4 is the most recent example. Others include a complete Defense Systems simulator for the B-55, and a POLARIS SUBMARINE navigational system. Full information is available on Reflectone's engineering and manufacturing capabilities. Write Dept. AW-2 for a copy of "New Dimensions in Aircrew Training".



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## HOW TO MEASURE A NOISE YOU CAN'T HEAR

Vibrations detected by a sensitive pickup, then amplified and analyzed by electronic equipment, enable Skop engineers to measure almost imperceptible "noises" occurring in rolling ball and roller bearings. Based on long-continued investigation, noise and vibration appear to be almost solely the result of minute deviations in the surface geometry of the rolling elements and rings. Detection of this surface "waviness" as a source of bearing noise is an important step in tribology towards solving the problem of producing quieter, smoother running bearings. Methods developed for monitoring wear have already resulted in the quieter bearings put aside for electric motors and other equipment, as well as even greater precision in the high quality bearings for aerospace and similar applications.

Advanced research is one of the reasons why Skop maintains its leadership in producing finer rolling contact bearings. Whether bearings you need—ball, cylindrical roller, spherical roller, tapered roller or precision miniature types—you'll find Skop your assurance of dependable performance. **SKOP Industries Inc., Philadelphia 22, Pa.**

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Advanced ball and roller bearing technology





## Space Age Problems

As the cost of the national space program climbs inexorably toward a \$10-billion annual level, it is reasonable that there are increasing questions from U.S. taxpayers as to what they are subsidizing and the nation as a whole can expect in eventual dividends from this huge investment.

Recently, a distinguished group of education, industrial, social scientists and municipal-level officials met with the top officials of National Aeronautics and Space Administration to determine what, if any, technical fallout from the space program will be applicable to the growing pains of the modern American urban community. They met in Duaneau House, a plush Victorian mansion built by a Scottish playboy as a present for his mistress of 17 years, just before their legal marriage.

Duaneau House, itself a near victim of urban growth, was recently rescued from a subdividers' bulldozer—purchased and refurbished by the city of Oakland. It is designed to shelter the type of thoughtful gathering that nurtured its public use, the result in a complex effort to establish a "transmission belt" for conveying both rapid progress of the space age to hounded municipal governments grappling with the negative effects of the urban explosion.

Oakland was a fitting site for this conglomeration because it sits in the middle of one of the most sprawling examples of urban growth in the country. The San Francisco Bay area is typical of how the face of urban life is changing with an explosive power equal to any space booster. California is targeted for more than half of the NASA Fiscal 1964 budget in industrial and aerospace contracts. So it should have intense interest as well as special skill in applying the new technology spawned by the space age to alleviate some of the most pressing problems here on earth.

Like most successful conferences, the Duaneau House meeting raised more questions than it answered. Among other things, it put several cracks in the suburban patchwork through which most of us view our affluent society. It also detailed many of the reasons underpinning the basic questions of the national economy and its stubborn refusal to start back on a healthy growth curve.

It was evident in the Duaneau discussions that while the space age budgets may provide a temporary stimulus to regional economies such as California and the Southwest, where \$1.6 billion has already been spent during the past three years, it cannot possibly solve the real problems now slowing the steady growth of the national economy.

Although everybody gets a painful reminder this month, it is still staggering to see the growth curve of taxes as a percentage of gross national product during the postwar period and a similar mountain slope depict-

ing the rise of federal, state and municipal employments on tax dollars. It is also startling to be confronted with the projections of the increasing available labor force which show a rapidly widening gap between this curve and the new jobs expected to be available in the future economy.

If the potential power of space technology as a new economic dynamo was scaled down considerably by the sober reflection at Duaneau House, it was also recognized that there will be considerable future economic power generated. But this technical fallout from the space age into the general economy will certainly not be uniform, and it may be highly unpredictable. If left to chance, its impact may be negligible. One of the clearer messages of Duaneau House is that industry, the social scientists and state and municipal officials must take an aggressive interest in space technology if they are to apply its benefits effectively to this nation's future.

NASA has already recognized this facet of the problem and is engaging a technical transmission belt from its program to industry—using eight major technically oriented universities from CalTech to MIT as its power generation for the flow. It has also organized an applications center at the University of Indiana to test the effectiveness of the various methods NASA will use to transfer its technology to industry. NASA is also hoping to organize a program for feeding industry people through its research programs to search for specific applications. This type of technical fallout is still only a trickle, but NASA is hoping to organize its channels to effectively in advance that handle a drop will be wanted and the economy will be well irrigated with its technical flow.

All of this, of course, is germane to the fundamental problems NASA and the space program face now and in the years ahead. This problem is simply how to convince the taxpayers who are backing the multimillion-dollar NASA annual budget that they are making a sound investment in the future of this country and that all of the explosion of outer space will pay substantial dividends as a better life on earth. Although the competitive aspects of the space race with the Soviet Union are important, they will not generate the long-term public support for what, of necessity, must be a long-term technical effort to be successful.

NASA faces a double-barreled problem for the future, not only to reach its technical goals successfully with prudent management of its public funds, but also to convince the source of those funds that the space game is worth playing for a long time to come.

—Robert Hutz



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Astrodata standard instrument amplifiers are designed to work with data acquisition systems to raise low level signals to useful levels for measurement, conditioning, monitoring, feedback loop control and indication. Many performance options are available to adapt these standard amplifiers to a wide range of applications.

Where custom designs are necessary, Astrodata's experience provides an exceptionally well qualified basis for meeting your individual requirements.

**TDA-675 Dual-State Amplifier** for both portable cabinet and rack mounting installation.

**TDA-675 Dual-State Amplifier** for both differential and single ended, floating amplifiers after low level conditioning.

INPUT RANGE: 0.000001 to 0.1 mV  
SINGLE ENDED AMPLIFIER: 100 to 1000 mV  
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REPEAT TIME: 100 to 1000 mV

**TDA-675 Wide-Band Single Ended Amplifier** for amplification after low level conditioning.

INPUT RANGE: 0.000001 to 0.1 mV  
SINGLE ENDED AMPLIFIER: 100 to 1000 mV  
DUAL ENDED AMPLIFIER: 100 to 1000 mV  
REPEAT TIME: 100 to 1000 mV

**TDA-675 Differential Amplifier** for single ended or high level multi-point systems.

INPUT RANGE: 0.000001 to 0.1 mV  
SINGLE ENDED AMPLIFIER: 100 to 1000 mV  
DUAL ENDED AMPLIFIER: 100 to 1000 mV  
REPEAT TIME: 100 to 1000 mV

**TDA-675 Differential Amplifier** for single ended or high level multi-point systems.

INPUT RANGE: 0.000001 to 0.1 mV  
SINGLE ENDED AMPLIFIER: 100 to 1000 mV  
DUAL ENDED AMPLIFIER: 100 to 1000 mV  
REPEAT TIME: 100 to 1000 mV

**TDA-675 Channel Stabilized Amplifier** for amplification after low level conditioning.

INPUT RANGE: 0.000001 to 0.1 mV  
SINGLE ENDED AMPLIFIER: 100 to 1000 mV  
DUAL ENDED AMPLIFIER: 100 to 1000 mV  
REPEAT TIME: 100 to 1000 mV

**TDA-675 Channel Stabilized Amplifier** for amplification after low level conditioning.

INPUT RANGE: 0.000001 to 0.1 mV  
SINGLE ENDED AMPLIFIER: 100 to 1000 mV  
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REPEAT TIME: 100 to 1000 mV

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INPUT RANGE: 0.000001 to 0.1 mV  
SINGLE ENDED AMPLIFIER: 100 to 1000 mV  
DUAL ENDED AMPLIFIER: 100 to 1000 mV  
REPEAT TIME: 100 to 1000 mV

## WHO'S WHERE

### In the Front Office

Dr. Ross Taylor Wilson, chief scientist for the USAF's Civil Aerospace Research, will join the University of Florida as research professor of aerospace engineering on 20 of Aug. 1.

John H. Baldwin, president, Dynastar Ltd., Oakville, Ontario, Canada, is a sub-advisor of Dynastar Inc., a subsidiary of the University of Toronto.

George N. Adams, Jr., administrator, NASA, is a sub-advisor of the University of Toronto.

Robert A. Baker, president and chief executive officer, National Computer, Inc., Dallas, Texas, is a sub-advisor of the University of Toronto.

William B. Lynch, president, American General Corp., is a sub-advisor of the University of Toronto.

George S. Farnham, executive vice president, Federal Electronics, Inc., Farmingdale, New York, is a sub-advisor of the University of Toronto.

Norman J. Phillips, vice president and general manager of the Air Force Research Office, is a sub-advisor of the University of Toronto.

John H. Baldwin, vice president and general manager of the Air Force Research Office, is a sub-advisor of the University of Toronto.

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## INDUSTRY OBSERVER

► Phoenix airframe mated for the Air Force/Naval F-101 tactical fighter program is to be a big procurement item for the manufacturing segment of the aerospace industry. Present plans call for the mainline, under development by Hughes Aircraft, to be produced in blocks of 1,000 units at a time.

► Russian MIG-21 aircraft received in India last month have been assembled and test flown. The surveys for the two MIG manufacturing plants in India have been made by Soviet specialists teams.

► Possible new deal for the T-122-2 jet fighter of subsonic hydraulic engine, suspended aluminum perches—has been investigated by Aerojet General under contract from USAF's Ballistic Systems Div. Problems arise inside flow characteristics of the jet and relative heat effects of the aluminum particles on the nozzle.

► Bell X-15-1 Hydrodynamic research vehicle under development for U.S. Navy Bureau of Ships is scheduled for rollout at the end of this month. After further fitting and checkout tests, it will be accepted by Bell for its flight test program, planned to start June 7, and be flown by a Bell crew.

► Test-in-flight system study and development by Cornell Aeronautical Laboratory has produced results applied to several non-manned aircraft systems, among them the equipment for British Aircraft Corp.'s TSR-2 strike-reconnaissance fighter. Cornell has been doing a modified Martin-Bell 157 as a test article for its own system development; pilots have made "touch-down" runs through single country.

► Phoenix-propellant rocket engine is being considered by National Aeronautics and Space Administration as a high-performance backup unit for the service module of the Apollo spacecraft.

► U.S. funding for the development of plasma-chamber burning in the Ballistic Missile 35-100 (bomber) will be stopped at the end of this calendar year. British will support development of the complete program for the variable-thrust engine. Modified Vickers Valiant test article is to be made in first flight, carrying a RS-100-1000 plasma chamber burning.

► Production of missiles for solid-propellant rocket motors has become a major subcontracting item in the U.S. missile program. Dollar values of missile contracts are beginning to approach those for the motor units.

► Grain loading and ignition for intermediate chambers of a solid-propellant rocket motor will be investigated in a study to be supported by NASA's Lewis Research Center. Competitive sub-contractor proposals were submitted at the end of March.

► Soviet's Sukhoi Su-26 has entered the early test stage, reaching speeds approximating 40 mph at Novosibirsk.

► Techniques for thrust measurement of pulsed hypergolic rocket motors will be studied in a program supported by NASA's Marshall Space Flight Center. Thrust range will be 50 to 100 lb, pulse intervals will range from 10 to 300 milliseconds. Industry proposals for the study were submitted in mid March to MSFC.

► All command-and-control for the integrated command-and-control system (INCCS) will be an operation by the end of this fiscal year. The include specially equipped Boeing C-135 command-post aircraft and Boeing B-47 communications-relay aircraft. Most of the C-135s and all of the B-47s are now being.

► Russian's first gas turbine-powered hydrofoil boat is scheduled for launch this year. Maximum design speed of the craft is more than 53 kt. Russians are operating a number of diesel-powered hydrofoil craft, some carrying up to 300 passengers.

ASTRODATA INC. is a subsidiary of the University of Toronto. The company is a subsidiary of the University of Toronto.



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## Washington Roundup

### Project Forecast Begins

Project Forecast, an attempt to study the overall future requirements of the Air Force, is getting under way in Los Angeles, away from the interruption of Pentagon offices. Although it is being concentrated in Air Force Systems Command's Space Systems Div., examples being, it involves more than space, and more than the command itself. USAF Chief of Staff Curtis LeMay, Lt. Gen. James Ferguson, deputy chief of staff for research and development and director of plans and operations and his program and requirements are expected to take part, as well as top officials of AFSC, Rand Corp. and Aerospace Corp. who will participate, giving the studies a strong civilian technical input. Although the effort is just getting under way, it is expected to be a complete survey of future needs at the Air Force for close to seven years.

Other explored question of whether the military services have a role in space and exactly what that role is or should be explored again this week by Rep. Otto Jeener (R-Iowa), committee chair, Senate Subcommittee, Assistant Secretary of Defense for Research John Ruffel and Air Force Systems Command's chief, Gen. Bernard A. Schriever, were scheduled to testify in closed hearings on Aug. 5.

### British Defense Policies

Security Administration will find quite different attitudes on an overall defense position with the United Kingdom. If Harold Wilson, leader of the British Labor Party, should win the coming election, Wilson and his staff here he would be inclined to "have the doubts" of British nuclear deterrent policy and then "reappraise or discontinue" the Nassau agreement that followed the Siskin cancellation. Wilson said he saw a paramount need to secure British support to conventional NATO forces—and to do so he would favor abandoning the "nuclear nuclear posture" of a "so-called independent, so-called choice." He did not believe it would be a realistic to evacuate key military bases where there was a chance to remain because "it is easier to stay than to accept" if feasible states.

Wilson wants a great effort to make new military, based on science, with the central thrust being the combination of science and technology from research and work to create goods. He cited the example of laserwork, developed by the Air Force's National Research Development Corp.

### Canada and Bomare

U.S.-Canadian relations, strained since State Dept. criticism of Canada's refusal to accept nuclear warheads for Bomare helped trigger Prime Minister John Diefenbaker's government last February, grew more in the campaign to elect a new government in coming days. With the Aug. 5 election only 11 days away, the House Defense Appropriations Subcommittee selected testimony in which Defense Secretary Robert McNamara said "At the very least, they [the Russians in Canada] would cause the Soviets to target Canada against them and thereby increase their missile require needs or else compel us to those Russian targets that would otherwise be available for other targets." In an attempt the Pentagon explained later that the U.S. has far more targets than Canada and indicated that the quote was taken out of context, the Diefenbaker forces said the quotation to fire the already heated debate over Canada's nuclear role and its dependence on the U.S.

Increased accuracy of the improved Minuteman ICBM is expected to make it about five times more effective against hard targets than the earlier version, McNamara told the subcommittee. Defense Dept. is moving for \$195 million in fiscal 1964 for continued development of the improved missile.

### Nike X Cost Estimate

McNamara told the same subcommittee that the current Pentagon estimate of the cost of implementing a Nike X ballistic missile defense for the nation is \$20 billion over a 10-year period. This is more than twice the Army estimates of several years ago, which were based on using the more expensive Nike Zeus system. McNamara added that "I personally will never recommend an anti-ICBM program unless a robust program does accompany it."

When McNamara was asked in secret appropriations hearings about reports that President Kennedy had ordered air support for the Cuban Bay of Pigs invasion in 1961, he said "There was no air support by U.S. forces planned or considered or considered at any time." But when he was asked about the air cover, he emphasized that he was talking about aircraft "for strike purposes," implying that he was making a distinction between the two types of support.

Marshall S. S. Byrnes, who was made commander in chief of Soviet rocket forces last year after several years as commander of subatomic defense, has been made chief of the general staff of the armed forces. No official announcement of the shift was made—Byrnes' new rank turned up in an article in the military newspaper Red Star. He replaced Marshal Martin V. Zakharenko, who is 65.

—Washington Staff

# Witnesses Challenge McNamara on TFX

Source selection board members, answering Defense chief's questions, dispute him on cost, commonality.

By George C. Wilson

Washington—Military witnesses strongly challenged Defense Secretary Robert S. McNamara's defense to the F-111 (TFX) contract by answering his own questions submitted to the Senate Subcommittee investigating the award.

McNamara made the critical request of Chairman John F. McClellan (D-Calif.) that military members of the source selection board who seconded Boeing for the F-111 contract be asked in terms of prepared questions while testifying before the Senate Permanent Investigations Subcommittee (AWA 91, p. 26).

Sen. McClellan asked the questions last week and received responses depicting McNamara's claim that General Dynamics' F-111 design decisions cost, commonality and more reliable than the competing Boeing design. These were highlights of the

testimony given to the subcommittee. ■ **Commonality.** Maj. Gen. Robert C. Bagg, commander of the Aerospace Systems Div. at Wright-Patterson AFB and chairman of the source selection board, said Boeing's design was in General Dynamics' favor. But for the fourth evaluation General Dynamics said more identical parts to achieve a common Air Force-Navy fighter, while Boeing proposed manufacturing down Air Force parts to obtain the lighter aircraft sought by the Navy.

Gen. Bagg said that by using common structures, cutting out parts or using lighter skin, Boeing saved 10% of the parts for the Air Force-Navy version similar but not identical. He said 60% of the Boeing design was identical, compared with 35% in the General Dynamics version.

In the opinion of the source selection board, Gen. Bagg said, the 1,490 F-111 being saved through this savings was worth it as much as weight was one item of Navy requirements and considered critical. General Dynamics said more common parts and structure but not more common parts to meet the Navy requirement for lower support. Boeing said the same aerodynamic configuration and met the Navy requirements by using smaller but lighter structural parts. I can see how that is a commonality, but having weight will tend to diverge faster during design while the General Dynamics aircraft are likely to retain the degree of interchangeability.

"Due to large differences in response," he said, "divergence will probably be greater in subsequent and equipment; and in the structural area, I would suspect there would be a divergency rather than a divergence." Asked about McNamara's contention that greater commonality of the General Dynamics design would simplify support and logistics, Gen. Bagg replied, "The degree of commonality that General Dynamics had over Boeing was in the parts that we do not necessarily stock and buy in quantity." He said these were parts which were replaced.

Brig. Gen. T. Allen Bennett, director of maintenance operations of Logistics Command, Wright-Patterson AFB, and the commonality sought in the F-111 was in the building phase of the aircraft. "These parts such as bulkheads, wing structure and the parts that are substituted parts are not the type of parts that really cost as the mainline items of our equipment as we get them into the inventory," he said. "They are not the high maintenance parts, so a contractor that has a higher degree of commonality in the construction of the weapon would not necessarily be the least costly to maintain as it got into the inventory."

Bennett, Gen. Bagg and Gen. Bennett said it would be more economical to have one aircraft for two services if a could accomplish the separate mission successfully.

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# Pentagon Ends Probe of Top Officials Over Leak

Washington—Defense Dept. ended its probe into a possible leak in the F-111 TFX contract which was also alleged to be a source of information that more than 800 Defense Dept. officials—including the deputy secretary—had been asked to reveal that they did not look at unauthorized documents to a reporter and to this leak detector told its accuracy.

Defense Secretary Robert S. McNamara ordered the Pentagon probe after the Washington Star published portions of an internal Air Force report claiming that investigations by the Senate Permanent Investigations Subcommittee had shown Air Force witnesses (AWA 91, p. 26) McNamara said the subcommittee had "blatant bad judgment" when he saw the documents he had written the report based on a leak, a week earlier for lack of depicting the Senate investigation.

McNamara issued the leak order to Air Force Secretaries Eugene Zuckert, who issued it over to Lt. Gen. W. H. Blumstein, USAF assistant general, who then directed internal and external Zuckert. The general said he was not involved in the case. Deputy Secretary, Ronald L. Glavin, Navy Secretary Fred Klopf, Assistant Secretary for Public Affairs Arthur W. Wier, and a number of other civilian and military staff in the Air Force, Navy and Office of the Secretary of Defense.

Schlesinger said, cut into the internal security, that the case was not a leak of information, but a leak of information. He said he was not asked to give a statement regarding to a leak detector told Defense Dept. officials and Secretary Kennedy—who was also asked the probe at his press conference—and he did not know how to respond. Schlesinger said the case was not a leak of information, but a leak of information. He said he was not asked to give a statement regarding to a leak detector told Defense Dept. officials and Secretary Kennedy—who was also asked the probe at his press conference—and he did not know how to respond.

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Schlesinger and Gen. Blumstein and his staff were "aware" of any leaks and military personnel in the Navy, Air Force and OSD who might have had any connection with the leaked report.

When Schlesinger was asked "In this context do we recognize that of this staff to be made regarding an unauthorized document would be rejected," he said, "We have an internal security that we think the unauthorized document would be rejected with the release of the information, and the Secretary expressed his concern with this staff. In this exchange took place."

Question: McNamara said he had the thing inside in a safe. Schlesinger: They said he said. Question: In view of the fact that he was trying to find out materials who might have leaked that safe?

Schlesinger: No, but in those documents there are always open questions. Who took it in the safe if there are always open questions? I don't believe he was aware in how many were involved.

Question: Are you just investigations of leaks here in the Pentagon, not in this case and past cases, which happened, news stories in the building?

Schlesinger: It didn't seem to me in the case. Question: A question is whether these investigations of leaks include legitimate news sources.

Schlesinger: My observation the last two years is that they have a lot of news. The next day the Defense Dept. issued this statement: "The Air Force announced today that the Internal Security Committee (ISC) has concluded that the case was not a leak of information, but a leak of information. He said he was not asked to give a statement regarding to a leak detector told Defense Dept. officials and Secretary Kennedy—who was also asked the probe at his press conference—and he did not know how to respond."

The same day Secretary Kennedy said in response to a question at his press conference: "I think that it was a mistake to suggest a subpoena, and I think I should say McNamara, when he learned of the case, that he was in a position to see and Secretary Zuckert charged it. So I don't think we need concern ourselves in the future about it. As a matter of fact, no subpoena was given."

problems of course is what happens when the war goes on through its travel, and the technical problems to be solved will naturally increase with the length of the contract. This case concerns the views of Dr. Harold Brown, director of defense research and engineering, who told the subcommittee the variable weapon was not an average risk.

Gold said McNamara, Gen. Bagg and Gen. Bagg said he agreed with McNamara's philosophy about meeting costs in terms of making sure the government and contractors fully understood the job at hand before the contract was signed. But regarding McNamara's contention that the Boeing cost estimates were overestimated, Gen. Bagg said "Our evaluation didn't show that one of them was completely accurate and we prepared to get the other one we could for the money."

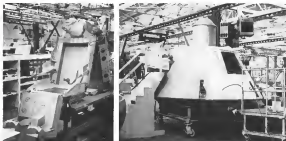
Sen. John C. Stennis (R-Miss.) asked how whether the choice of aircraft was "based on price and cost questions?"





Photo-control master models used in construction of 19 boilerplate command module spacecraft for impact. Right and above testing are shown at left in North American Aviation's Space Sciences and Information Div. facilities at Downey, Calif. Models shown are the same framework of spacecraft-forward and aft sections and heat shield cones and outer skin. Three light-colored models in lower row are 140 deg. models for inner and outer skins of upper and lower sections of command module. Forward heat shield model is dark-colored. Top row shows models for inner and outer skins of glass fiber heat shield aft heat shield wall inner-skin and outer-skin model of heat shield crew compartment assembly. Boilerplate weld structure is shown in foreground. Forward bulk of boilerplate command module is visible construction (right). Welder is working top of support. Fabrication is made of aluminum. Cylinders on top is for test.

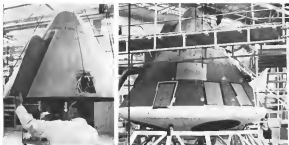
## Apollo Spacecraft Boilerplate Production Advances



Boilerplate model of station test is fabricated of aluminum alloy. Titanium alloy is being considered for Apollo station test because of higher strength and lower weight. Workmen used outer cone bulk of Apollo spacecraft boilerplate model 31 which will be first model to be tested into orbit with Saturn II booster to test spacecraft-booster compatibility (right). Cloth covering on right side of capsule keeps interior covered with dressing-coating agent which etches surface slightly porous to bonding on surface. Glass test of cone simulates ablative material for test purposes.



Open-end aluminum honeycomb with protective space-making is placed between outer skin of heat shield and inner skin of heat shield to achieve weight and strength of Apollo heat shield (above). All glass fiber heat shield would be two halves. Glass fiber is used for heat shield because of lower cost. All heat shield master models (right) is used to achieve after outer and inner skin of glass fiber heat shield are noted. These master models are necessary to fabricate the glass fiber heat shield, inner and outer skin and construction of the two. Command module master models are at right. About 1,600 people are employed on the Downey, Calif., production line. North American eventually will turn out a total of 19 boilerplate spacecraft. All phases of production are under close control.



Forward heat shield of boilerplate model scheduled for full short tests at NASA's White Sands facility shows detail of top portion of state added recently for better aerodynamic stability, during re-entry (left). Boilerplate command module, which will be used for launch escape system tests at NASA's Manned Spacecraft Center White Sands module specialist site (left) that testing is shown at right. Two chutes, one on each side of spacecraft, made of ablative material will increase reentry stability of Apollo spacecraft during re-entry pilot to make their deployment. Fleets circle on heat shield is for optical tracking during full short tests.

# Democrats Try to Ease NASA Funds Cut

By Alfred P. Abramo

**Washington—Kearney.** Administration and Democratic leaders in Congress are making a concerted effort to ease the \$5.7 billion civilian space budget request from drastic cuts urged by the Republican leadership and some conservative Democrats.

Republicans are asking for reductions of up to \$700 million in the new obligation ceiling being asked for by the National Aeronautics and Space Administration in Fiscal 1965.

President Kennedy contended last week that the NASA budget might sound a slight possibility, however, but defended it against the reduction requested by House President Eisenhower.

## Congressional Decision

Congress leaders unanimously made a decision that the U.S. would not continue to be second in space, President Kennedy said. "We are not second in space today because we started late."

"I don't think we should look with equanimity on the prospect that we will be second all through the rest of the century and possibly the seventh," he said. "We are not second in space today because we started late."

In New York, Dr. Edward C. Weiler, executive secretary of the National Aeronautics and Space Council, told the Associated Press that the administration believes that the U.S. cannot afford to cut back its space program after the stupor of Sputnik 1.

## Frick Resigns

Apollon project manager Charles W. Frick has resigned from his post as NASA's Mission Services Director, Houston, Tex., after the project manager's resignation was announced by NASA's director of manned space flight, Robert Gilchrist, and that he accepted Frick's resignation with reluctance.

Robert O. Fland, former acting project manager for Apollo, said Robert Frick has been named chief of the Lunar Extravehicular Module program, a position formerly held by Fland.

Frick became Apollo manager in February 1962, after serving as assistant to the program since December, 1961, while employed by General Dynamics.

and the country's prestige throughout the world.

While not there can be no second hour for doubting that the USSR will require its growing space competence for military purposes if it finds that such action is effective. "We must be able to handle such a threat."

The predicted Soviet Russian space spectacular this year, including the docking of two spacecraft.

Notwithstanding, defined and basic details of the space budget request was made by House Majority Leader Carl Albert (D-Idaho), a leading member of the House space committee. He noted a report which listed the "consequence" of the \$74 million cut urged by Republicans.

Albert said that reductions could cut into the Apollo program, delaying a manned landing on the moon, and threaten the jobs of 63,750 people, 10,750 of them working at identifiable contract locations in 16 states and 15,600 employed by subcontractors at various unidentified places.

Albert's figures were based on the assumption that most of the reduction would come out of the manned flight program, which is not likely. But the fact that cuts are made in the space program area, but of jobs has been an objective argument in Congress.

## Committee Hearings

House space committee subcommittee hearings on NASA's budget request, set for next week, will include a hearing on the subcommittee on manned flight program which will recommend a cut of about \$100 million to \$115 million in the form of a cut in the number of facilities not needed immediately. Subcommittees on space science, advanced research and technology and application facilities also are expected to recommend reductions.

Following the launch of Launch 4, the Soviet Union last week (see p. 11) the House space subcommittee on manned space flight again took a close look at the cost of the U.S. manned space program. Subcommittee members heard Gen. O. Brewster Holmes, NASA's director of manned space flight, of the U.S. program was given to "win the race" to the moon.

The Apollo commitment, while not detracting departure from the position NASA officials took when they in a manned acceleration of the Apollo program in May, 1961. At that time, Dr. Hugh L. Dryden, and NASA Administrator James E. Webb said the program was being accelerated because the manned lunar landing offered a distinct goal following the U.S. race to over-

take the Soviet Union and lead once on the moon before Russia.

"To be successful in Apollo," Holmes said last week, "it is not necessary to win the race."

He said the objectives are broader and include ensuring the nation's space flight capability and the level of technical and scientific education.

He warned against both slowing down the program and spending at a substantial increase rate.

"We're running a reasonable engineering and scientific program within our capability that is not based on reaction to Soviet activities," he said.

## Military Systems

Prior to Holmes' appearance, Norman V. Peterson, Air Force technical director at the Edwards, Calif., Flight Research Center, and the air of the center, said that the military is not a compelling reason for developing systems which would be of military value.

Albert's figures were based on the assumption that most of the reduction would come out of the manned flight program, which is not likely. But the fact that cuts are made in the space program area, but of jobs has been an objective argument in Congress.

Peterson said he would not be surprised to see the House make a manned circumlunar flight "necessary" again, the early orbit method.

Holmes said that the U.S. and the Russian have not displayed the basic capability for such flights.

## NASA Advisory Group

Washington—Two new advisory groups have been appointed by the National Aeronautics and Space Administration to analyze the operation and management of NASA's manned flight program.

Chosen by Dr. Marvin J. Kelly, Short H.B. N.Y., chief president and chairman of the board of Bell Telephone Laboratories, Princeton, and Dr. Harold W. Bell, president of the Military Development and Systems Engineering, Bell Telephone Laboratories, James McCann, Boston, and Air Force major general now is vice president of the Massachusetts Institute of Technology, Dr. Arthur E. Brynildsen, Los Angeles, and now is president of the office of engineering for the Douglas Aircraft Co. and now a consultant to the NASA administrator, and Dr. Herbie R. Sides, Massachusetts, N.Y., president of Aerospace Industries Laboratory, Long Island, N.Y.

## Soviets Launch Lunik 4

Washington—Soviet Union launched a \$210-million Lunik 4 "automatic station" into a parking orbit into a 31-day trajectory toward the moon on April 3 without docking at the launch site.

The 14-ton station was closed the first stage of the launching rocket, according to the Soviet news agency Tass. Lunik 4, which made the first photograph of the horizon of the moon in October of 1958, weighed only 145 lbs. It is the first unmanned Soviet lunar probe since Lunik 3.

Comments by Soviet officials during the first two days of flight showed all the possibilities—lunar photography on a single pass in Lunik 3 made lunar orbit, lunar soft landing and lunar roving vehicle. The new "automatic station" has been used in the past to test in Russia's Venus and Mars probes. Lunik 4 and beyond lunar orbit.

The delay in launching actually on 1954 on Russia and Communist Viet Nam and he believed there would be other flights of automatic stations and manned before lunar flight to the moon.

## McNamara Says Primacy of Top Leaders Is Main Pentagon Issue

By Katherine Johnson

Washington—Fundamental part in the Defense Dept. is the primacy of the individual—military or civilian—who bears total responsibility for the defense establishment," McNamara stressed. "Many of the actions we have taken during the last two years to improve the management of our personnel and logistics operations were recommended by this and other senior members of the Congress and by various non-governmental committees and commissions. 16 and over 15 years ago."

For example, the reorganization of the Army, National Security, which was put into effect last year, had been recommended to the President by Secretary of Defense Robert McNamara in 1952 with the suggestion that a reorganization of the National Security would be a more useful than building into a huge one, but I believe that it is long overdue."

McNamara replied that "it is not just the primacy of the civilian or a military individual, but after the fact of an individual, military or civilian, who bears the total responsibility and can use the total problem in all of its aspects."

Representatives of individual services, he said, "has raised, not out of my desire. I think, to advance their personal position or the power of their particular department, but rather because of a honest belief that it would... provide the combined wisdom of our establishment."

This was McNamara's first appearance before the Senate committee, headed by Sen. Paul Douglas (D-Ill.). That committee has supported his management policies and applauded his cooperation with General Accounting Office in its efforts to bring about cost reduction in the defense establishment.

McNamara told the committee that he personally reviews all GAO reports on Defense Dept. waste and inefficiency and that all GAO correspondence is reviewed and handled by either himself or Deputy Defense Secretary Russell C. Johnson.

"It is extremely difficult to change the individual's view of doing things in the defense establishment," McNamara stressed. "Many of the actions we have taken during the last two years to improve the management of our personnel and logistics operations were recommended by this and other senior members of the Congress and by various non-governmental committees and commissions. 16 and over 15 years ago."

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year effort and expenditure of about \$1 billion. The aircraft nuclear propulsion program was terminated by McNamara in 1961 (AW Apr. 2, p. 3).

Overhead in bringing the program was characterized by McNamara as "shortcuts to early flight." McNamara stated: "Only a relatively small fraction of the money expended was applied to the development of a new program, namely the development of an efficient aircraft with a potentially high performance."

• For firing boat. McNamara said the Marine Corps' experience in the example of a project advanced into the production phase before even the basic design problems were solved. He set the cost of the eight-year effort at \$440 million, including \$200 million in the production contract.

McNamara said development was continued even though model tests in 1955-56 disclosed serious design deficiencies. A production contract for an experimental plane was placed in 1956, even though flight tests in 1957-58 showed technical deficiencies, he said. It was canceled in 1959.

During the program's defense period, McNamara said the commitment, Defense Dept. was to make a major place in depth the main, unknown in our sea effort. Two or more competing approaches may be supported, he said.

After planning and a sea feasibility study of "young" experiments, we are in chapter three having to accept, reject or terminate existing projects after they have been started," McNamara said.

Developments such as atomic and hydrogen bombs and experimental nuclear missiles which add a new dimension to military capability, justify great costs, but such developments are rare.

The typical development program, if successful, is achieve a capability that can also be achieved in other ways or represents an improvement of old capabilities," he continued. "In these cases, the program is not as great and the expenditure of a more national and orderly approach to development and production is fully paid."

The F-111 (DTP) Air Force-Navy fighter (see p. 27) was cited by McNamara as the most significant action so far to eliminate parallel projects for the same goals, he said.

McNamara indicated extensively on the threat that is still possible, progress, huge development costs must be eliminated, two production lines must be set up, two separate operations must be set up, and support equipment must be established, and even disbursements must be made of the two sets of obsolete systems and support equipment that eventually will accumulate.

• Nuclear-powered aircraft. After a 15-

# Explorer 17 Returning High-Quality Data

By George Alexander

Cape Canaveral, Fla.—Quantity and quality of data being returned from space by Explorer 17 satellite, last week, is expected to enable National Aeronautics and Space Administration to analyze the first detailed and comprehensive analysis of the earth's atmosphere structure.

Previous American and Soviet satellites have sampled only selected parts of the earth's atmosphere. Explorer 17, the first satellite designed solely for broad investigation of the composition, pressure, temperature and transparency of the upper atmosphere.

Explorer 17, built by NASA's Goddard Space Flight Center, Greenbelt, Md., was launched here at 9 p.m. (EST) Apr. 2 in the Douglas three-stage Delta vehicle. Preliminary analysis indicated the satellite achieved an apogee of 595.5 mi. per, a perigee of 138.4 mi. per, a period of 104.4 min., and an inclination of 57.6° deg.—all extremely close to pre-calculated parameters.

Explorer 17 designated 8.6 prior to its successful launch, carried eight instruments, eight to measure the atmospheric composition, two spectrometers, four vacuum gauges and two electrostatic probes. The satellite is a 15-in. dia., 40-lb. standard size sphere with the instruments protruding from its surface. When spectrometers, built by General Electric Nuclear Corp., Milwaukee, Calif., are designed to detect the amounts of helium, atomic oxygen and nitrogen and molecular oxygen and its traces in the atmosphere region situated by the satellite.

Spectrometer, resembling Faraday

cage, generates two magnetic fields. The first extends about 16 in. mm. in front of the spectrometer and the second extends within the detector.

Particles trapped in the first field are swept by a probe extending in front of the instrument mouth and are funneled into the intense of the second. There, the ions encounter the second magnetic field, which is of constant strength, and are deflected according to their mass to one of six collector plates. Particle impingement on a plate causes a current flow which can be measured to indicate the amount of particles collected by the spectrometer.

Four vacuum pressure gauges—two built by the Equipment Co. of National Research Corp., Newton, Mass., and two by Westinghouse Electric Tube Div., Elmsford, N. Y.—are providing data on the diurnal (variation of) particle distribution in the atmosphere. Data from ion current collectors have confirmed that the satellite's ionospheric signals on the side facing the sun and corners on the shadowed, or night, side.

National Research Corp. gauges are of the Backlund variety, named after Cleveland scientist Dr. P. A. Backlund, and are more sensitive to the lower pressures of higher altitudes. These range is about  $10^{-11}$  to  $10^{-14}$  atm. Hg. Westinghouse gauges are of the Bayard-Alpert type and are most effective for pressures ranging between  $2 \times 10^{-10}$  to  $2 \times 10^{-12}$  mm. Hg.

Operational ranges of the different gauges, both of which sense particles to generate a measurable flow as collector plates complement each other.

Electrostatic probes, of the Langmuir type and provided by the University of Michigan, extend about 12 in. from the surface of the satellite shell. A van de Graaff voltage, is applied between the cylindrical probe and the shell. Particles flowing through this potential induce a current flow, the magnitude and shape of which are dependent upon the particle and temperature of ions and electrons in these altitudes.

Because Explorer 17 has no data storage capability, it operates directly upon command of ground stations at Goddard Point, Md., St. John's, Newfoundland, and Woomera, Australia. As the satellite orbits within view of one of these stations, a command is sent to it, indicating the operation to transmit data.

Second command is then sent to a 10-stop rotary switch, selecting the data source of the instruments to be operated. There are eight possible results.

- Two Redhead gauges only.
- Two spectrometers only.
- Two Bayard-Alpert gauges only.
- Two electrostatic probes only.
- Spectrometer, two of the vacuum gauges and electrostatic probes.
- Spectrometer, the other two vacuum gauges and electrostatic probes.
- All four vacuum gauges and electrostatic probes.
- All eight instruments.

Naval and fourth stops on the switch are back-up commands for turning the equipment on and off.

After the sequence has been decided, the instruments operate for 270 sec., and then automatically shut off. Readout is direct to the ground station observing the satellite on first pass (satellite pass).

Explorer 17 also looks solar cells, a long battery, an 800 lb. of aluminum batteries for electrical power. Batteries, charging from 1 amp. to 199 amp. by capacity, are expected to have an operating lifetime of about 75 hr. Total life here of the satellite, which will operate only 4.5 min. out of every 96-min., orbital pass, is estimated at two to three months.

Explorer 17 is spin-stabilized at 1.5 rpm. An input system, consisting of a digital bus system, a split bus system and several bus-to-bus systems, will redirect to the ground station the orientation of the satellite in relation to the earth and reflect the sun in the sensor. This orientation capability will facilitate later data studies.

Explorer 17 is the first scientific satellite to use a pulse code modulated (PCM) telemetry system. The system provides 40 channels of digital data, with each channel capable of 20 min. per word every second. Data transmits

## Advanced Engine Study

Investigation of an advanced jet turbofan engine based on gas turbine engines, incorporating operating characteristics required for earth orbit, under way, in planetary landing will be sponsored by NASA's Western Operations Office, Santa Monica, Calif., in a 12-month, \$300,000 effort.

Industry proposals will be submitted Apr. 20 for the task, which will include a design study and development analysis of the proposed engine program. Items being a full thrust turboshaft engine in range of 2,000 to 40,000 lb. Equipment will be to save thrust requirements from full value to 1/10 (10% thrust) of thrust will be 500 hp. Equipment will be suitable for engine operation thrust vector control and will have to be compatible with other changes to fuselage in the engine.



**Jet power goes to sea.** Pratt & Whitney Aircraft is developing a family of high-performance marine turbines to power hydrofoils, hydro-skimmers, large displacement vessels, and small boats. These space-saving engines will lead to faster and more responsive ships that can be controlled directly from the bridge. Pratt & Whitney Aircraft provides design and manufacturing leadership for many applications, in and out of this world.

**Pratt & Whitney Aircraft**  
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## BLOODY PARALYSER

It was 8:00 PM, on the night of August 25, 1918. The sun was setting over the airfield at Ochey, France. Captain W. B. Lawson and Lieutenant M. C. Purvis, followed by their chauffeurs, climbed up to the front cockpit of their Handley Page 0/100 bomber. Their mission: to bomb Marston's British chemical works, manufacturing of poison gas.

It was another night raid designed to demoralize the Germans and destroy their industrial might. What began as another routine bombing mission toward the end of the war, really had its beginnings almost four years before.

In November 1914, the British Admiralty sent out a call for help. They desperately wanted a plane capable of making Channel crossings with a heavy load of bombs. Specifically, they wanted a plane with two engines, two crewmen, six 100-pound bombs and a maximum speed of 72 miles per hour.

Frederick Handley Page, one of England's foremost airframe designers, presented his Kipling specifications to Commander Murray F. Suter, Director of the Admiralty's Air Department. Inspired by what he saw, Commander Suter asked for more. In what is perhaps the greatest over-ambitiousness of all time,

he used "give me a bloody paralyser of an aeroplane." The result was the Handley-Page 0/100—the first strategic bomber in the history of aerial warfare. The builders of the Handley Page 0/100 had their work cut out for them. It was the largest plane ever assembled in Britain up to that time. The 63½-foot long fuselage had to be built in three parts, with the center portion holding the bomb bay.

The wings were also built in sections and folded in to fit the plane into a hangar. The top wing had a span of 106 feet, the lower, 70 feet. The top of the top wing stood two inches off the ground.

The 250-hp. Rolls-Royce engines were mounted between the wings. The forward section held a side-by-side cockpit for the pilot and co-pilot and in the emergency was a pit for the forward gunner-bombardier. Another gunner's position was behind the wings. There were no brakes—the big plane stopped by means of a giant springing tail.

The Handley-Page first saw action on November 26, 1918, while attached to the 1st Wing of the Royal Naval Air Service in Dunkirk. It was originally used as daylight patrols off the coast of France. On April 23, 1917, these planes, each loaded with four or six 100-pound bombs, attacked five German destroyers off Goeree and left one burning.

But it is a matter less than three days later, on 4/18/17, was shot down. From that time on, the Handley Page became a night bomber.

In the beginning, only one Handley-Page would go out on a night raid. But that was enough. One 0/100, carrying sixteen 100-pound bombs and a crew of three, could do as much damage to its Defflandville-4 bombers with a total crew of 12. Moreover, the 0/100 needed only 84 gallons to fly 100 miles, versus 128 gallons for the DH. 4.

On October 2, 1917, four 0/100s were transferred to the new No. 10 "A" Squadron, attached to the 1st Wing at Ochey, France. This wing was later to become part of the Independent Force, R.A.F.

The only heavy bomber group of the R.A.F. in France until August 9, 1918, it was later equipped with Handley-Page 0/400s—a slightly modified version of the 0/100s. An array of 40 planes at one time landed such cities as Karlsruhe, Strasbourg, Bern, Bernstadt and Mannheim.

The attack on the Salsburg works in Mannheim by Lawson and Purvis was a particularly daring one. The first plane barely missed the tops of the smoke stacks as it passed 200 feet over the

factory. The second plane dropped its bombs and exploded in mid-air, gone from 500 feet up.

Strange as bombing raids by the Handley-Page were more dangerous when compared to similar missions of World War II, but they brought the war to the enemy. And they established the Handley-Page bomber as the "bloody paralyser" of World War I.

### Did the Bloody Paralyser carry Leach Relays?

No. We didn't set up shop until 1939. But Leach Relays have been on all kinds of airplanes, jets and missiles since then.

### What kind of relays?

Balanced separate time delay, solid state, and subminiature relays, in name just not. The Leach Half-Six Crystal Gun Relay is one of our present. It was designed specifically for greater current applications.

### Don't you also make communications and telemetry equipment?

That's right. Our command systems are now in use in many Air Force aircraft projects. And we're a leader in the minimum tape recorder field. Our latest recorder weighs 10½ pounds and is being developed for Project Apollo. Our smallest one is the 25-volume unit that takes up to 2000 G's of shock in temperatures from -100°F to +100°F.



### How do I get in touch with Leach?

We've just built our new corporate headquarters in San Marcos, California. But we have other offices in Los Angeles, Ames, San Francisco, New York, Washington, D. C., Dayton, Seattle, Boston, Minneapolis, Zurich, Munich and sales representatives around the world. For more about what we do and how we do it, you, write!

**LEACH**  
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astronomer, mounted on the bottom of the satellite, provide nondestructive ionospheric propagation.

It also was the first precision-timed atomic satellite. The 75-lb., 3.5-ft.-dia. thin shell was built by the Solid State Physics, Inc. was designed to be leak-proof so that no gases would be allowed to leak out into outer space. The shell was mounted to one earth station, with ground stations.

Mounted down by the Delta vehicle was described as low and hot" by NASA project personnel from Goddard's Solid Propellant Branch, which conducted the launch. Their first stage burned for 144 sec. Second stage, then separated and, also burning for 4 sec., burned for 150 sec. After 30 sec. of second stage, burning the third stage, the spacecraft was jettisoned.

A 7½-sec. coast followed second stage burnout. At F-470 sec., the third stage, solid propellant motor ground and burned for 40 sec., separating Explorer 17 into orbit.

Orbiting equator of Explorer 17 was the spacecraft's ionospheric scanner with the Delta, which has taken only in its first attempt. A 1-sec. burn was deliberately introduced into the countdown Apr. 2 so that the vehicle, which had been awaiting 100-sec. check periods, would not place the satellite into orbit too early. Launch, therefore, occurred at 17 sec. past 9 pm.

Since launch a 1-sec. launch window between 9 pm and midnight so that the earth station of the report system would not accidentally lock on the sun and cause solar radiation damage.

First mission was to test the Explorer 17, a, read about the ionospheric layer's height from the Woomera station and orbited the opening of the four ionospheric planes. These stars had been contacted and tested prior to launch. The second mission—existing network operations—was given 4½ sec. later to the Woomera station.

### NASA Flight Research

NASA's Flight Research Center, 11½ miles AFM, will fund a design study for a geostationary ionospheric propagation, processing and control system for use in ionospheric and human research program. This is being submitted for review on October 1, 1978, for the 10th and 11th and 12th and 13th and 14th and 15th and 16th and 17th and 18th and 19th and 20th and 21st and 22nd and 23rd and 24th and 25th and 26th and 27th and 28th and 29th and 30th and 31st and 32nd and 33rd and 34th and 35th and 36th and 37th and 38th and 39th and 40th and 41st and 42nd and 43rd and 44th and 45th and 46th and 47th and 48th and 49th and 50th and 51st and 52nd and 53rd and 54th and 55th and 56th and 57th and 58th and 59th and 60th and 61st and 62nd and 63rd and 64th and 65th and 66th and 67th and 68th and 69th and 70th and 71st and 72nd and 73rd and 74th and 75th and 76th and 77th and 78th and 79th and 80th and 81st and 82nd and 83rd and 84th and 85th and 86th and 87th and 88th and 89th and 90th and 91st and 92nd and 93rd and 94th and 95th and 96th and 97th and 98th and 99th and 100th and 101st and 102nd and 103rd and 104th and 105th and 106th and 107th and 108th and 109th and 110th and 111th and 112th 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# Confusion Clouds International Air Travel

U.S. wins some backing on IATA fares, but new delay in aviation policy release stirs uncertainty abroad.

By L. L. Doty

Washington—Riftures among cabinet members involved in international air transportation became chaotic last week as an open-air situation appeared on Atlanta and Pacific routes and the new U.S. international policy for civil aviation again became bogged down at the White House.

As of last week, the better fare conflict (AW Apr. 3, p. 25) has plagued the industry into wide-open confusion, making it difficult to determine the exact stand each government was taking. That much was clear, however: the U.S. now is not facing the solid opposition it originally encountered.

The fare battle now involves the entire international airline industry, with Great Britain and France disapproving the cost of a fare increase and the U.S. adamant in its stand against the increase. Last week, Canada unofficially said the U.S. will not disapprove all fares, including cargo rates, adopted in Montreal, Aug.

Japan, Mexico and—reportedly—Greece had also sided with the U.S. position, and several European nations were not holding as firm on the issue as originally indicated. The latter group, it was revealed, was not so much opposed to the rate increase as it was disturbed over the Civil Aeronautics Board's de facto failure in making a decision.

The international issue was further complicated by the fact that, among U.S. and foreign flag carriers as a result of the White House's continuing delay in releasing the long-awaited policy on international air transport (AW Mar. 25, p. 21).

A major factor in postponement of the policy's release has been a new look by White House staff members at that portion of the policy pertaining to competition. The policy, currently stated that competition between U.S. airlines on international routes should be increased, and that these routes should continue to compete with foreign flag carriers on a free enterprise basis.

This provision displeased the transport lobby of Pan American and TWA, and qualified the chosen instrument concept (p. 42). But later last month, ATLACO President George Meyer, prompted by a group of Pan American pilots who have shown ordered competition, expressed his support for the policy.

At the same time, in discussions with White House aides and Justice Secretary William French Smith, Meyer stressed that the guiding principle of any policy should be the strengthening

of U.S. airlines to protect against reduction in competition. The action forced the White House to reconsider whether a single carrier operation in competition with foreign carriers can be formed a monopoly, and also again raised the question of U.S. subsidies. Apparently, a compromise solution had been reached, but as of last week, there was no indication of the degree to which the basic policy had been revised.

Indirectly, the rate issue stems from the Civil Aeronautics Board's application of the new policy's duties on lower fares. The holding was that as the policy called for a lowering of rates, it would be weakened substantially if the subject is approval of higher fares.

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## New German STOL

Dornier-DO GmbH is completing design plans for a short-takeoff and landing (STOL) transport aircraft designed by the Stuttgart STOL 101A. Scheduled development of the 20-passenger DO 31 replacement will be done at the Post Air Show in Bonn.

Final designs are to start development and production of the aircraft which also has been designed to carry up to 3 tons of cargo in its all-purpose freight compartment will depend largely upon the possibility of meeting airframe government loading support.

Ernst Heinkel Flugzeugbau AG has been actively seeking government financing for a single transport design, the HE 111B1, but some have been, such as the Deutsche Luftfahrt Verein German airlines, however, has issued a public house requirement for its aircraft in this category. (AW Mar. 31, p. 297)

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C-141 Wing Section Joined to Fuselage

Workers at Lockheed Georgia Co. lower left wing of C-141 Starliner. Wing is hoisted into place by crane to be joined to fuselage. Right wing is already in place. In background, an engine is used to bring wing into place. Workers push wing into place to be joined and bolt it in place. Each wing section weighs 51 tons.

change in planned under the terms of a bilateral agreement.

In New York, IATA President J. L. Dumas, president of Air France, agreed that this late situation had caused confusion and was bad for business. Dumas said that the late position was moving out of IATA's hands and into the field of governments, a transition he deplored. He said IATA is the best institution that can be employed for settling fare issues and added, "to subordinate government" wing for IATA "making it a very retrograde step."

The late dispute also involves other phases of the new U.S. policy, and could cause an immediate deterioration of how high the U.S. stands to adhere to it. To summarize as it was an act of the policy's points at the stage undoubtedly would damage the face of the overall policy.

The policy views international air transportation as a private business or industry, not as a civil air act or act such as that in which other countries accept it. FAA Administrator N. E. Babbie has said that the U.S. stands on the "hardcore" in fact, not in theory.

The CAB, however, has had the effect of removing position, the current discussion of air private entry prior from the industry and placing it in the hands of the government. Unless the CAB changes its decision within the

next 30 days, which is not considered likely here, further negotiations on the fare issue will be conducted on a diplomatic level between governments, including the IATA conference unless not leaving U.S. carriers with an act in the establishment of fare. Thus the private enterprise phase of the policy will be concluded.

The policy also suggests that permission rather than have should be used as representation with other nations. The Board action undoubtedly leaves its own staff views on virtually all current of other reports indicate that the Board, by adhering to the policy on fare, has violated the previous air agreement.

Defectors over the fare issue has created a poor atmosphere for the presentation of the new U.S. policy to European governments. Testimony, representatives of the State Dept., CAB, FAA and the White House strong emotion on, scheduled to visit several European nations in a group to discuss the policy, happening Apr. 15.

These plans have been postponed on several occasions, and either the issue is settled by the middle of this month, further postponement can be expected. Meanwhile, the delay is creating apprehensions among foreign flag carriers as to U.S. intentions, so that when and if the policy is presented it will probably have a guarded, skeptical reception.

## SST Research Awards

Lockheed—Boeing—Douglas Airlines has awarded research awards to Lockheed-Galileo Co., Boeing Co. and North American Aviation.

The research will be conducted under a government industry cost sharing agreement whereby industry will contribute \$1.6 million and the government \$1.6 million toward the total program cost of \$3.2 million. Lockheed will perform research in three areas: under a \$893,000 contract and Boeing and North American will perform research jointly in two areas under a \$500,000 contract.

Lockheed will study the state of wing box and wing design material fatigue and fatigue life analysis. Boeing and North American will work together in three areas: variable wing wing planform, metalized thin-film wing structure, material thickness, and wing structure design, including loading and structural loads.

# CAB Reflects U.S. Anti-Monopoly Attitude

By L. L. Doty

Washington—Civil Aeronautics Board, almost since the time it was created under the Civil Aeronautics Act of 1938, has consistently blocked moves by Pan American World Airways to replace its chosen instrument status and to compete with U.S. domestic carriers.

A major factor frustrating Pan American's chosen instrument goal has been the U.S. govt's consistent antimonopoly attitude, which has understandably borne strong influence on the Board's decisions to reject and route cases. The Board's thrust is limiting Pan American from domestic operations is not in clear cut, however, and appears to rest on tradition as much as economic and legal reasoning.

The CAB has leaned heavily on the wisdom of the Civil Aeronautics Act of 1938, and its later amendments, to justify its opposition to a single carrier system in international service. The act made, in part, that the Board should consider as being in the public interest "competition to the extent necessary to assure the sound development of an transportation system adequately adapted to the needs of the foreign and domestic commerce of the United States."

John T. Yeppe, Pan American's president, takes issue with the phrase "to the extent necessary," and terms it ambiguous with respect to international transportation. He has asked, "Does 'competition to the extent necessary' mean controlled competition between American flag carriers in addition to the maximum supply of foreign flag carrier services?" Does it mean that we shall have a zone where to meet foreign competition or does it mean that we should have a control American flag effort to take on the world open market set up by the proposed trading nations to represent them in the international field?

Yeppe probably never drew a direct verbal answer from the government, but these questions were answered fairly and squarely by CAB action as early as 1946, when the Board granted a transatlantic route temporary certificate to American Export Airlines, and as late as 1962, when the Board staff completed a new survey or report on competition.

The word of a certificate to Pan American competition was a difficult move in 1946 since, a year earlier, the CAB had stated it was opposed to "unwarranted, excessive competition and wasteful duplication of service."

Nevertheless the anti-monopoly philosophy of the U.S. began to influence CAB thinking at this time, and the question of whether the U.S. should adhere to the antimonopoly policy or later regulated competition was raised.

The correct approach came early. The Board reasoned that there was sufficient reason to justify the open line of two carriers and that that traffic would continue to grow, particularly during the post war period. In addition, the Board found that it had not

usually less authority over international operations than over domestic services, and therefore competition was needed in order to check abuses that possibly could arise from a monopoly or oligopoly.

By 1945, the CAB was ready to restate its policy of competition with increased confidence. In the *Northeast Airlines et al., North Atlantic Route Case* it stated the "competition to the extent necessary" portion of the act and added:

"That is the actual policy which we are called upon to administer in our decisions and any arguments or contentions directed to the validity of such policy are properly addressed to the Congress and not to this Board."

To make certain that there would be no misunderstanding as to the decision's intent and meaning, CAB bluntly stated that U.S. "competition to international air service is European cases are should not be subjected to one comparison."

Yeppe, meanwhile, lost no time in taking his case to the Congress (JAW April 1, p. 41).

In writing of its measures, the Board admitted that foreign flag carrier competition would increase and develop, but found that this was not an adequate reason for abandoning the antimonopoly policy of the government—that is the policy enshrined in the Civil Aeronautics Act. The Board added: "The public interest is defined by statute, requires the operation of at least one U.S. carrier. To restrict international air transportation to one carrier would place upon a small managerial group responsibility for handling matters having international national significance."

The statement is cold enough to withstand scrutiny, but it ignored one fact: Until 1940, Pan American's small managerial group had served U.S. international air transport interests wisely and successfully. Since 1927, although it did have the advantage of heavy air mail payments from the Post Office Dept. during that period.

In the same case, CAB denied Pan American the right to operate within the domestic route complex. The reasoning behind the decision appears to have been developed to support a passenger restriction. The Board admitted that domestic carrier operating internationally would have "some advantage" over Pan American, was Pan American interested in the international field.

But this advantage would be medi-

## CAB Route Action

Washington—Pan American World Airways has a survey of interest in its present route structure at the following recent CAB American Board actions on other fields, approval or disapproval to start:

- Board order E-18351, dated May 4, 1962, would terminate service into Paris and Rome.
- Board order E-18120, dated March 1962, would terminate the airline's entire Alaska operation.
- Board order E-18101, dated May 4, 1962, would terminate the airline's Mo Keweenaw to Fairbanks, Alaska, only U.S. flag service on this route.
- Board order E-17119, dated Aug. 7, 1961, terminates the American's 31-year-old route between Miami and the Gulf Coast. Issue only would involve Pan Am service from San Francisco, Oakland.
- Board staff proposal dated Oct. 6, 1962, would eliminate Pan American service into San Francisco, San Diego, Guadalajara, Managua, Antigua and Ecuador.

went to Pan Am's. It is going with the route under the previous agreement.

In May, 1963, the CAB said 3-2 against the acquisition of American Overseas Airlines, but when the decision was reversed by President Eisenhower, CAB approved the transaction but gave new status to TWA in particular, in the words of President Eisenhower, "vigorous competition, growth by new routes."

That too, Pan American made its last major bid for a network of domestic routes. It petitioned the CAB for a U.S. domestic route which that converted all its current and selected parts of service with one another, but which, in the process, also provided the major route segments or linkages of the network specified in its American Airlines, Eastern, Delta, National, Northwest, TWA and United States

Board voted against that in July, 1950.

During the ensuing decade, Pan American held to its goals but made no serious move to reach them until the initial merger with TWA was proposed.

Meanwhile, during that time, the airline has thrived despite its setbacks and failures. Initial study of the company's rise from 1939 million in 1951 to 5795 million in 1961. Revenue passenger miles flown from 1.5 billion in 1951 to more than 5.7 billion in 1961. The company's net profit for 1962 is an estimated \$14 million, an undoubtedly the largest net profit that will be shown for that year in any of the world's scheduled airlines.

(This is the last of three articles on Pan American World Airways' bid to become the U.S. choice instrument and to secure domestic routes to an international system.)



First BAC 111 for BUA Nears Completion

First British Airways Corp. BAC 111 transport transport scheduled for delivery to British United Airways is in final stages of construction at Vickers-Armstrongs (Aircraft) plant at Hawking, England. It is expected to be a two-engine twin-jet transport. Main fuselage top structure completed; floor plates built to 15 ft. by 10 ft. last month.

## Pan American's Growth—1951—1961

Following table illustrates the growth of Pan American World Airways during the 10 years following its acquisition of American Overseas Airlines.

	1951	1955	1959	1960	1961
Revenue passenger miles (100)	1,281,704	1,763,075	1,320,075	1,264,320	999,300
Passenger	309,385	401,360	341,634	341,147	281,000
Freight	152,082	152,082	152,082	152,082	152,082
Total	1,583,087	1,965,235	1,472,158	1,416,402	1,081,382
Total available seat miles (100)	1,583,087	1,965,235	1,472,158	1,416,402	1,081,382
Load factor (%)	81.3	82.4	82.2	82.2	82.2
Revenue passenger per aircraft	30.4	31.7	30.4	30.4	25.0
Operating revenues (100)	145,551	185,447	158,145	152,199	142,017
Operating expenses (100)	115,551	145,551	125,551	125,551	115,551
Net income (100)	30,000	39,896	32,594	26,648	26,466
Rate of return on capital employed (%)	11.0	12.0	11.0	11.0	11.0
Rate of return on total invested capital (%)	6.5	6.5	6.5	6.5	6.5
Total assets (100)	277,251	302,772	287,722	287,722	277,251
Total liabilities (100)	118,831	121,722	118,722	118,722	118,831
Long-term debt (100)	17,751	41,125	41,125	41,125	41,125



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## United Single-Class Fare Causes Concern

By James R. Ashlock

New York—Industry is closely observing United Air Lines' single-class experiment, airline officials expect, for clues that might help solve the complex fare problems causing concern among domestic trunk carriers.

Many airline officials readily admit that the confusing variety of fares now available has complicated rather than eased the frustration of abundant seats and deficient revenues.

"I don't believe anyone can actually say that a profitable amount of new business has been generated by this fare mess," one airline spokesman said.

United's contention is that rather than another trial-and-error bid for market expansion, it is simply trying for a larger share of the available traffic, particularly business and government travelers. The service is priced slightly above coach and substantially under the standard transcontinental first-class fare.

"We've never said that single-class would expand the market," a United official said. "But we do believe that many business travelers whose fares are more than 50% above coach would be attracted to it. The more complex fares let us remove from corporate travel routes what interest."

### Strong Opposition

United inaugurated the service Mar. 10 from Chicago to San Francisco using strong advertising opposition from American Airlines and Trans World Airline. American advertisements in Chicago read, "Do you really want to sit next to TWA's and American jet Coaches 990 and 580, both with first-class coach seating and standard coach fares, who compete with United's single-class Boeing 730s?"

Single-class was inaugurated with high load factors out of Chicago, but line fares spread back to where it is only a few percentage points above United's existing load factor, which averaged about 45%.

United is expanding the service to include Cleveland-Chicago and San Francisco-Salt Lake in addition to New York-Chicago-San Francisco. It will decide about June whether to consider more aircraft to single-class for further expansion in the experiment.

Many sources feel that the single-class trial won't prove itself conclusively until it is attempted in a highly competitive market, such as Idlewild-Los Angeles. American is believed to be considering a transcontinental single-fare effort sometime Aug. 28—the date when car-

riers after schedule to conform with daylight saving time.

Despite widespread use of the term "single-class," airline officials concede that fare phenomena can still exist on taking more business seats from the competition.

"There are as many different opinions on fare levels as there are airlines," a spokesman in American said. "The fare structure is based on traffic volume. If an opening is business developed, you'd see airline shifting their fare levels upward quickly."

Single fares, spokesmen are, simply competitive price cutting wrapped in a kind of "public benefit" to help their approval by the Civil Aeronautics Board. And the Board has readily approved almost every fare scheme that offers lower rates, rigid less of special conditions such as type of aircraft, time of travel or use of the booking program.

"The decision of the Board will all be evidence lower fares, or perhaps I should say any fare that dilutes airline revenues," a spokesman said. "The chairman is on the fence, but he usually votes for lower fares."

However, CAB did deny TWA's request of its 12.3% due transcontinental expansion fare, which would have equaled the much rate to Chicago plus the third class fare to Los Angeles as established by Continental Air Lines.

Whenever a carrier obtains a fare reduction its competitors feel pressed to meet it. The only reason United's competitors haven't fought as fiercely is because it is considered a fare increase.

Result of the competitive fare scramble has been the emergence of eight different fares for transcontinental travel, many from the \$150.90 jet first-class rate down to a 10% coach fare for servicemen who take seats on a space available basis. Even the aban-

doned family fares have been revived, despite a rule on travel halfway of the known fare first class.

Transcontinental fares are single compared with the East Coast situation governed by the unstable Florida tourism. As more as 100 different fare combinations in Florida have evolved, including individual fares for travel at night, day of week, month, type of aircraft etc.

The discouraging result has been that instead of expanding traffic, the only expansion has been in airline direct expenses and ticket refunds, confusion. Travel agents are complaining that their clients for more explanation the fares are exceeding commissions on the actual sales.

Eastern Air Lines, which admits it has been a leader in formulating special fares, has now asked the CAB for an investigation toward simplifying the fare structure. R. B. Muehl, president of National Airlines, has indicated the proposal.

"The result of all this activity is the aim of joint rational fares in a middle which few but tariff experts can comprehend," Korman said in asking for the program. "It is time for the Board to take positive, concrete action to simplify the price structure."

### CAB Stalls

CAB isn't taking the blame for the fare problems, with some justification. The carrier, not the Board, designed the current pattern. But many officials within airlines feel the Board should make more direct action to prepare fare money to the industry itself, rather than to the individual carrier proposing it.

Continental's three-class service from Chicago is an often-cited example. "But was it pure and simple effort to divert traffic into Chicago to earn profits for Continental's not having a route on into New York," a Continental ad competitor said. "And while it may have helped Continental, it hurt those doing the long-haul on the same northern transcontinental carrier."

Not do the fare plan for the airlines can ever mean change on the basis that might reward the situation. The overriding influence is still to keep a larger share of the available market, and spokesmen feel there will be a continuance of fare experiments by individual carriers, with the competition forced to follow suit.

A spokesman in TWA said most promotional fares are a "shot in the arm" strategy, an effort to grab off a bit of extra business, in offpeak seasons. That's why they usually have a cut-off

### Allegheby Investments

Washington—Allegheby Airlines is noted \$750,000 in cash and assets and from 1952 under a development program.

Lois O. Baker, Allegheby president and here newly that two new carrier subsidiary companies, Allegheby Van Horn and Allegheby Service Corp., was authorized by the value last year.

In addition, the carrier has purchased controlling interest in International Air Service, a Puerto Rico firm which operates as agents in the Caribbean and is a major vacation party distributor in that area.





**WORLD'S NEWEST JET** Boeing 727, America's first short-range jetliner, is shown taking off on early test flight. Powered by three rear-mounted turbofan engines, the 727 can operate from 3000-foot runways. It will bring potential advantages to hundreds of smaller cities. The 727 can carry

70 to 114 passengers at speeds up to 600 mph. Now undergoing one of the most intensive test programs in aviation history, the 727 enters service early next year. Three airlines have ordered 331 Boeing 727s: American, American Airlines, Eastern, Lufthansa, Texas-Australia, TWA, and United.

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## American Airlines Pessimistic Over Increased 1963 Industry Profits

New York—American Airlines continues to take a pessimistic view of the prospects for increased profits in 1963 for the industry, and American's annual report issued last week expressed that American's 1962 earnings—though based above the average of its main competitors—failed to cover its \$1 common stock dividend paid since 1958.

American did get the \$1 dividend and to do so deducted \$1,400,000 from its retained earnings account to cover the difference between its profit figure of \$7,995,000 and total dividend payments of \$9,395,000.

Despite the negative on earnings, American's balance sheet shows the airline is in strong financial health. At Dec. 31, 1962, American had \$119.5 million received in government and other securities. With 70 cash accounts and receivables, totaling \$99 million, American was in a position to meet all its current liabilities of \$118 million and also pay—without income to any borrowing—\$40 million due this year in payments for its Boeing 727 under American's agreement to pay the airline \$100 million cost of the 727 program out of aircraft's generated funds.

In 1960, American was able to cover its operating stock dividend because of retention of the initial loss of its jet expansion which resulted in lower

depreciation charges and consequently higher earnings.

New American plan to increase its option to purchase all currently leased engines in its Convair 440 and Boeing 720 fleet. It already has purchased the engines and propellers of its Lockheed Electra that formerly were leased, which resulted in a \$100,000 increase in earnings in 1962 and a retroactive adjustment of 1961 figures to increase earnings that year to \$77,000.

Under the lease contract, cost of the engines was, in effect, paid out over a seven-year period. With purchase, the engines and propellers will be depreciated over the 12-year useful life schedule. American's 1962 earnings, however, showed a 10% increase over 1961, and the 764 million figure was a decline from 782 million revenue ton miles in 1960.

## Accounting Office, FAA Study Utilization of Traffic Controllers

Washington—Federal Aviation Agency's use of air traffic control manpower was the subject of a study now in progress as a study team now being made by the General Accounting Office.

While the study was not directly related, a major purpose of both is to report whether the most efficient use is being made of FAA's force of controllers, who also are more than half of the agency's reported staff of 54,000 employees.

GAO considers its study as typical of many which it conducts in other areas of government for checking whether project and efficient management methods are being used. It has not made a study of air traffic control personnel use before and was prompted to do so at this time because of the large part of FAA's budget needed for air traffic control.

The main purpose of the GAO effort—American's a major assistance study—is to determine whether FAA is "overstaffed" in the area, a spokesman explained. The survey will report about air traffic control.

Meanwhile, FAA's Office of Management Services is conducting its own study. Comparative figures gathered in that are nationwide, but are expected eventually to provide more accurate readings on the exact number of personnel needed on air traffic control and to present where the greatest manpower needs are applied among the agency's seven regions.

swings. The 1962 increase resulted from several additional appointments for American's (FAA) that partly offset the increase in earnings.

Declining load factor resulting from increased competition on routes and increased capacity of jets combined with lower revenues were the cause of the earnings decline, according to American's President C. R. Smith. Expansion maintenance was one area of disappointment, but American said an intense effort is being made to bring these costs in line. Depreciation and interest charges also increased sharply, a result of the transition to jets.

American's total revenue rose from \$4.1 billion in 1960 to \$4.8 billion, and operating income rose from \$147 million to \$157 million. Available ton miles rose from 1,773 million to 1,762 million while revenue ton miles rose from 724 million to 764 million. A slight decline 1961 figures, however, and the 764 million figure was a decline from 782 million revenue ton miles in 1960.

These are some of the study's most significant findings.

- **Control tower numbers** 17,648, each of whom—on a statistical basis—handled 571 aircraft during Fiscal 1962, for a daily average of 1.6 aircraft. Long and short of aircraft was handled by the entire region, with 2,483,547 movements handled by a 185 controllers. Control controller workload was in the control region where 3,980 controllers handled, or 677 each at the rate of 1.9 per day.

- **En route traffic control centers** handled 10,600,122 aircraft during the year, at an average of 6,337 center positions for a national total of 1,616 aircraft handled by each position. The rate amounted to a theoretical daily rate of 4.4 per position.

- **Airport control tower operations** totaled 1,711 personnel who handled 27,450,000 aircraft operations during the year. The rate per individual controller was calculated at 7,719 operations for the year, or roughly 20 per day. This includes both terminal and en route traffic handling and takeoffs. The Eastern region with 1,154 tower operations had the largest staff, but the largest rate in the continental U.S. was handled by 114 Southern region tower controllers who had an individual annual rate of 9,158 operations.

However, the Alaska region, with only 27 tower operations, had a rate of 14,761 aircraft operations per operator, based on the 1962 total of only 395,000 operations.



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**DOUGLAS BUILDS GREAT TRANSPORTS**



## AIRLINE OBSERVER

►Watch for Aer Lingus to enter the British BAC 111 short-haul jet transport. The airline has studied the Boeing 727, the de Havilland Trident and the Sud Caravelle as well, but the 200-300 seat stage length and traffic requirements within Europe point to an airplane growing about 80,000 lb. The Douglas DC-9, if it goes into production, also would fit the category. Negotiations for financing new aircraft through the Irish government are under way.

►British West Indies Airlines is continuing flights over Cuba on its Jamaica-U.S. routes. The carrier's Vickers Viscount fleet thus avoids an extensive base disadvantage in competing with jet services operated by Pan American or BOAC, which must follow a dog-leg route pattern to by-pass Cuba and its territorial waters. Cuba has not banned the Trinidad airline from flying over the island.

►Eastern Air Lines' loss of \$14,991,365 in 1962 (AW Mar. 25, p. 37) would have been greater if it had not made a change in the depreciation schedule for its jet aircraft. Depreciation period was extended from 18 to 42 years, and residual value from 18 to 15%. Using an example of the Southwest line saving, Eastern and the new rule would have increased depreciation expense by \$1.1 million if applied to 1961 figures.

►Civil Aeronautics Board has said no new transatlantic service case hearings will be set before July 1. Finally will be given three cases: Pacific Northwest-Alaska Case, U.S.-South America Route Case, Service to Spokane Case, Delta-British Western European Case, Transatlantic Route Renewal Case and proceedings growing out of Pan American-Guest-Flagship anti-trust case. In the local service area, staff efforts will be focused on "use it or lose it" area airport program, route alignments and possible transatlantic route suspension. Supplemental carrier deceleration certificates will be given priority hearings on these applications.

►British Overseas Airways Corp. lost about \$10 million for its fiscal year ended last week. The precise figure will not be released until a report on BOAC's financial structure (AW Nov. 5, p. 52) is made to Minister of Aviation John Aneurin Bevan.

►Federal Aviation Agency has ordered eight sales flight studies without setting a total of \$3.4 million from Raytheon Co. Utah will be installed as part of FAA program to institute high altitude positive control of aircraft operating above 24,000 ft.

►All local service carriers will show a profit for 1963. According to a study prepared by Systems Analysis and Research Corp. for the Area of Local Transport Airlines, annual rate of subsidy paid the local service carriers will decline about \$1.5 million in 1965.

►KLM Royal Dutch Airlines is studying a reorganization of its management structure to handle its overseas operations into larger regions, with regional heads reporting directly to E. H. Lurie, KLM's new executive vice president. One possibility would be to combine the new separate areas of the U.S., Canada and Mexico into one region. KLM sales structure within the U.S. now also be reorganized into five major sales regions, with sales representatives added at eight new cities besides the 25 U.S. offices now operated by the airline.

►Trans-Canada Air Lines is planning to acquire one type of transport to replace both its turboprop Vickers Viscounts and Vikings. The world's largest carrier already has two-month test-in-progress Douglas DC-8s and the new transport. The Boeing 727 is favored by some in the airline, because of the relatively lightweight as well as short-haul requirements in the carrier's route structure. TCA recently phased out the last of its piston semi-turboprop Douglas DC-6s and is selling six Viscounts for sale, although the aircraft are still in service.

## SHORTLINES

►British Overseas Airways Corp. is choosing the regional marketing concept in its U.S. sales operations and will continue managerial activities in New York, with the sales force throughout the U.S. reporting directly there.

►Chicago's O'Hare International Airport was the nation's busiest air terminal in 1962, peaking 260 1/2 loads, Los Angeles International Airport, into second place. Chicago's Midway, once the general leader in total operations, ranked 97th.

►Civil Aeronautics Board last week found that local airline service between Reno, Idaho, and Las Vegas, Nev., is not required. Three local service carriers had applied for the route.

►Federal Aviation Agency has lowered the landing limit for parallel approaches and landings at Chicago's O'Hare Airport. New maximums allow parallel landings with 400 ft. clearance and 1 mi. visibility. Present limits were 500 ft., 1.5 mi. Non-parallel landings are 200 ft., 1 mi.

►Frontier supplemental airlines were granted extended services and foreign cargo charter rights last week by a 5-2 CAB decision. Denying services Chris Gannay and Whittier Gifford and operating rights should not be regarded pending a full and complete evidentiary hearing on their application.

►Lufthansa German Airlines has started Boeing's first "Air Shuttle" operation between Frankfurt and Hamburg. Martin A. MacArthur, president of Eastern Air Lines, which acquired the shuttle plan, was in Frankfurt to participate in inauguration ceremonies for the service.

►National Air Carriers Association and the seven supplemental air carriers belonging to NACA questioned slightly more than 1 billion passenger miles in 1962 and 299 million cargo ton miles without a passenger or cargo trailer. According to NACA, its member operators 71% of all estimated supplemental airline passenger miles were fully flown.

►United Air Lines paid \$58,810 to engineers in 1962 through the company's magazine program. Top reward went to W. L. Williams, who received \$9,495 for developing a method of repairing aircraft hydraulic system pump components.



What name is on the first 1.5 Mc recorder?

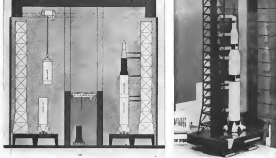
AMPEX

Here it is: a 1.5 Mc per track, multi-track recorder! And Ampex is the first to have it. It's called the FR-1400. It will give you the broadest bandwidth yet in longitudinal recording. What's more, it utilizes solid state electronics throughout—all in one rack. It has four speeds, each electrically switchable with no adjustments needed. And it comes with tape search and shuttle to provide quick data location and permit any portion of the tape to run repeatedly without operator attention. What about per-



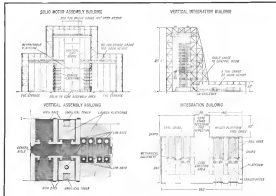
formance? Outstanding! It offers better noise time and minimum ringing on repeat starts, low intermodulation distortion, and improved flutter. Ampex also brings you a new 1.5 Mc tape. Is both you'll find the same engineering precision, the same superior quality, that has made Ampex first in the field of magnetic recording. Write the only company providing recorders and tape for every application. Ampex Corp., 534 Charter St., Redwood City, Calif. Worldwide sales and service.

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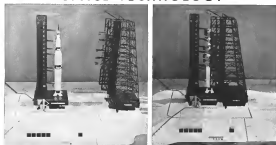
**CROSS SECTION OF VERTICAL ASSEMBLY** building for Saturn 5/Apollo at Cape Canaveral. Left indicates massive size of the structure. Scale model, right, shows Saturn 5/Apollo on its mobile launcher platform before leaving vertical assembly building.

## Cape Facilities for Saturn 5/Apollo, Titan 3



**ENGINEERING DRAWINGS SHOW** proposed Cape facilities for Titan 3 (top left and right and bottom right) and Saturn 5 (bottom left).

## SPACE TECHNOLOGY



**ARMING TOWER IS BEHIND** launch stand, left, to receive transporters and to move launch platform to pad. Background arming tower, right, contains launch vehicle and capsule while retro-rockets, stage rockets, engine rockets and separation mechanisms are installed.

## Keyed to Delivery of Flight-Ready Boosters

By George Alexander

Cape Canaveral, Fla.—Delivery of flight-ready boosters and spacecraft to the launch stand constitutes the basic element in the design of facilities now under construction for the Saturn 5/Apollo and Titan 3 programs, representatives of the National Aeronautics and Space Administration and the Air Force stressed at a recent meeting here.

Speaking before the space flight test conference of the American Institute of Aeronautics and Astronautics, Lt. Col. Robert A. Peterson and Col. Clarence Buford, Air Force, officials of the NASA's Launch Operations Center, and James F. Lowrance, Air Force Corp., discussed the Air Force Titan 3 program. Detailed details on the facilities being built for them respectively.

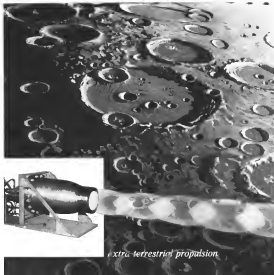
Design approach of both programs is similar: the complete launch vehicle and spacecraft system will be assembled and checked out in a facility built for that purpose and will be rolled out to the launch stand only when ready for flight. All three spokesmen said that the concept will allow high launch rates, increased system reliability and reduced time and cost.

Peterson, chief of the heavy space vehicle services office at the Launch Operations Center, said that the accuracy and complexity of the Saturn 5/Apollo system and the varying launch rates fast in cycle times and capacity reliability demanded of it, necessitated a new approach to the design of launch facilities.

vehicles, will be mated through the low bay area before mating to the overall vehicle the S-IC booster, in first stage, will proceed into a high bay.

In operation, a launch vehicle and its mobile launcher, checked out and ready for flight—will be driven into one of the high bays. As S-IC boosters, having been delivered to NASA's Marshall Space Launch Area from the vertical assembly building by barge, will be rolled into the transfer aisle on a horizontal transporter. Stages then will be attached to the 144-ton (dry weight) S-IC and the 210-ton and 175-ton stages will lift the stage lower on dolly and place it in a vertical position. The stage then will be lowered into the hold-down support cranes on the launch table and secured.

After most platforms have been dropped around the S-IC, the unit will be mated to the handling device. Four semi-circular bearings will be installed on the base of the S-IC, the bearings of the launch, followed by installation of four stabilizing bars (AW Aug. 13, p. 52). S-IC then will be ready for the launch. S-IC will be connected to ground support equipment, contained within the launch bay overhead bays; and this will be connected through a high speed digital data link to the launch control center at one end of the building. Four and a half hours before launch, the launch vehicle will be mated to the launch control center and will be based on the launch pad. Concept tests will



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Many space missions require rocket engines whose thrust level can be accurately controlled over a wide range. STL scientists and engineers are developing a family of such engines, including the 5000 pound hypergolic rocket engine shown above. These engines can vary their thrust across a throttle range greater than 40 to 1 while maintaining high combustion efficiency and limiting propellant residuals. With each test firing of the 5000 pound engine (and its 500 pound counterpart), the weight of STL scientists and engineers grows heavier in areas of extra-terrestrial propulsion. New problems have been created by this project, by STL's work as prime contractor for NASA's OGO, by its prime contractor

air assignment on a new series of Air Force-ARPA contracts, by its Systems Management activities for the Air Force's Atlas, Titan and Minuteman programs, and by other space responsibilities. Openings are in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Spacecraft Mechanisms, Propulsion Systems, Missiles Research. For Southern Calif., or Cape Canaveral positions, write Dr. R. C. Potter, Dept. A-4, One Space Park, Redondo Beach, Calif., or P.O. Box 42771, Patrick AFB, Fla. STL is an equal opportunity employer.



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begin on the component level and then progress to subsystem, system and finally complete vehicle.

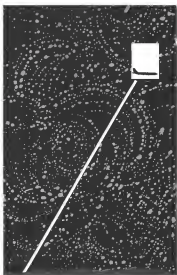
An instrument unit will be positioned above the S-IC at a height of 114 ft in the bay. This will be a 200-in dia., 3-ft tall, 2-ton module containing the Saturn V's guidance and control computers, gyro-stabilized platform, fuel gauging, command antennas and decoders, instrument system equipment, telemetry, tracking transponders and electronic distributor. It will be connected to the instrument tower through the same cable that will be used later for launch. S-IC and the instrument unit will be electrically coupled through S-2 and S-4B stage simulators for vibration tests. These simulations will be housed in test gaskets rooms at each within the high bay corresponding to the height of the actual stages.

All test data will be relayed to the control center in the same looped cable link.

After solo tests of the S-IC in all-systems test areas of the S-IC, the S-2 and S-4B simulators and the instrument unit will be run. NASA engineers then will proceed to mating the actual S-2 and S-4B stages to the S-IC booster. It is expected that checkout of the S-IC will take about eight weeks.

While the S-IC is undergoing checkout, the S-2 and S-4B stages will be put through similar tests in separate cells on the low bay area. The ground support equipment which will be used in these centers will be identical to that used at the manufacturer's plant and at static test stands.

After checkout, the 37.5-ton (dry weight) S-2 stage will be moved into the transfer aisle and mated to the S-IC advantage adapter section. It will be moved to the high bay area by the 175-ton crane, which has a hook height of 167 ft, and there transferred to the 250-ton crane. The latter then will lift it atop the S-IC for mating. A similar procedure will be followed with the 14-ton (dry weight) S-4B third stage. The instrument unit will be disconnected from the unlinked tower at the completion of the S-IC test program to allow mating of the S-2 and S-4B stages. After the three stages have been assembled together, the instrument unit will be installed atop the S-4B and all stages connected to the unlinked tower. A series of stage-separability tests then will be run, including manual, simulated emergency and auto-ignition, egress, followed by an actual launch vehicle vibration test. At the end of this approximately 12 week, checkout and checkout process, the Saturn V will be ready to accept the Apollo spacecraft system. The three-ton command module and its associated modules which will have already



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**TEST**—The thermal model (center) is tested in the Bristol 20" x 24" space chamber with liquid nitrogen, control water and solar simulator illumination to validate the analysis for a specific set of conditions.



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**WHERE IDEAS  
UNLOCK  
THE FUTURE**

undergo 14 weeks of tests in the pyrotechnic and checkout building, also in the Murray Island Launch Area, will be delivered in two sections: the outer nose section and inner section in an external test and the Launch Extension Module, as a separate unit.

Then, spacecraft products will be delivered to the high bay in the vertical assembly building and assembled into one complete system in the launch platform. Subsequent tests will be run in the spacecraft and launch vehicle before mating the two. The 250-ton crane then will place the Apollo in the instantaneous test adaptive system.

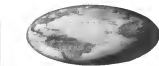
Also mating a combined spacecraft and launch vehicle system test will be conducted, including capture and retention of umbilical connections, internal power on flight batteries and electrical diagnosis of stages during a requested cruise. At some flight moment as possible will be used for a simulated flight test, approximating as closely as possible a vehicle countdown and flight. Tests will be conducted and all systems must perform satisfactorily before a decision will be made to transport the complete vehicle to the launch stand.

The launch vehicle, tower, open when all this activity will take place horizontally, is a platform with an integral umbilical tower. It consists of five major elements.

• **Launch platform.** This will be a two-story steel structure, 33 ft. tall, 160 ft. long and 151 ft. wide, upon which the Saturn 5/Apollo will be assembled and from which it later will be flown. On the top deck of the platform, two dual-purpose arms will protrude to support the stages and spacecraft during assembly and to receive the launch vehicle at the time of launch until full thrust develops in the five F engines of the booster. Each arm will be 71 ft. long, with a 6 x 6 ft. base, and will weigh 30,000 lb.

Reaching the dock, the launch platform will be divided into 24 compartments on each of two levels. The compartments, varying in size from 150 to 1,000 sq. ft., will house cranes, propellant storage racks, checkout and launch-associated equipment. Platforms will have a cutout through its center to allow exhaust of the booster engines.

• **Umbilical tower.** 100 ft. tall, 60 sq. ft. at its base and 48 sq. ft. above the 40 ft. mark, the umbilical tower will be mounted on one end of the launch platform. A horizontal rail system, capable of 300 gpm rotation, will be mounted on top of the tower and will have a maximum hook height of 576 ft. It will have a lifting capacity of 12 to 24 tons, depending on the variable hook masses (rises of 50 to 50 ft. Two 600 gpm elevators will be centrally



## How the world became flat

Across Canada, over the pole, circling Europe, to the Middle East, reaching the Pacific and linking much of Southeast Asia is a microwave military communications network, binding together the continuity of free nations. ■ Billions of bits of data and countless phone conversations and teletype messages are exchanged daily. Contact time from one continent to another is typically only a matter of seconds. This looks sense doesn't it? Figuratively speaking, the earth had to be flattened to permit contact between transmitter and receiver. Over-the-horizon communications at microwave frequencies was made possible by forward-scatter troposphere propagation—"tropo" for short. Kilowatts of microwave energy are needed. They are generated by amplifiers: klystron tubes. ■ The modern power klystron had its beginnings in the discovery of the principle of velocity modulation at Göttingen in 1894. Other brilliant expressions of the same basic principle developed independently in the U.S. in 1907 and 1928. ■ The power klystron is inherently large. Because it is also essentially simple, it easy, with skill, be designed simultaneously for high power, high gain, long life and military ruggedness. All these are essential to the task of "tropo" communications. So successful was this approach to the problem that the klystron is the sole microwave power source for every element in the network. ■ And so successful has one company been that its amplifier communications klystrons are used almost exclusively. That company is Eitel-McCullough. Eimac has designed, developed and delivered over 86% of these communications klystrons. The life of an Eimac power klystron in this service ordinarily exceeds 25,000 hours. More than a few are now past the 50,000 hour mark. ■ Upon such formidable foundations, Eimac continues to forge into other areas. It is now at work in a government-sponsored effort aimed at achieving a million watts of continuous microwave energy at a frequency whose limit today is about 50,000 mc/sec. (This is an almost unbelievable amount of energy, anyone can do it. There is good reason to think Eimac can.) ■ Eimac ground-station klystron amplifiers are now in worldwide service in satellite relay (transmission) and Eimac has developed new ultra-lightweight driver klystrons for the world's largest linear accelerators. All largely on self-sponsored research programs. ■ These are typical of Eimac's technical achievements in electron power tube development. Anyone can prove the earth is round. It takes special skill and capability to flatten it.

1. This story is told more fully in "The World as a Flatland Model: How far you can go" 2. It concludes this story with the story "Flatland: How far you can go" The discovery of the velocity modulation principle is one of the greatest discoveries of science in Eimac. A copy of the Eimac 1000 report on the history of science for the tubing.



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located within the tower and will survive 15 drops, the lowest being the upper compartment of the launch platform, about 35 ft above the ground and the highest being 340 ft above ground.

• **Unsheltered wing area.** Light weight all wing area, covering a length from 35 to 45 ft, will join the tower to the launch vehicle. Of steel frame construction, the 100-wt. tail and ribbed side arms will provide pressure, access, power, propellant and pneumatic lines to all three stages. Pilots will enter their spacecraft on a special 65-ft long reinforced extend. All arms will have flexible undisturbed to large load platforms in place during wind run and will be capable of supporting up to 1,000 lb—or approximately five times their rated load. Each arm will have two independent pneumatic push-off piston motors to guarantee disconnection of the arm at the proper time during the countdown.

• **Living accommodations.** Three drive-in, push-propellant seats, each must lift off vertically, water-quench seats for fighting extreme and heated loads, all mounted on the top deck of the launch platform.

• **Operational test and launch equipment.** Chlorine computers, power supplies, fuel tanks and other special electronic equipment will continuously monitor the status of the launch vehicle as it travels from the vertical assembly building to the launch stand. This equipment will be located in compartments within the launch platform.

Total weight of the launch vehicle and tower is expected to be 16.5 million lb. Weight of the upper Saturn 5 and Apollo spacecraft is expected to add another 500,000 lb to the mobile platform.

Launcher-mounted tower, which is completely assembled, launch vehicle and payload aboard, will be moved to the vertical assembly building to the launch stand by a crane, hoisted by the rail-guided crane, moved, and under development by the Mission Power and Shovel Co. (MW P&S, p. 77), will be 151 ft long and 154 ft wide and will weigh 1.5 million lb. It will move on four double-tracked, steel-tired tracks, each 41.3 ft long and 7.5 ft wide. Two Diesel generators will provide 5,600 hp for a main drive system powered by electric traction motors on each pair of wheels. The four crawler tracks will be located from one corner position or more, be recommended as independent front and rear units. Turning radius will be 900 ft.

Velocity of the crawler will be 2 mph unloaded and 8 mph on a level surface when fully loaded with a Saturn 5 and Apollo. On a 1% grade—the equivalent of the runway leading up the launch stand—the crawler will be able to do 0.5 mph. It will be able to move its load against a steady headwind of 15 mph.

Hydraulic jacks, integral with the tracks that drive the steel tracks and located on the corner of a 90-ft square, will have a 77-in. maximum stroke to lift the launcher-mounted tower platform. Jacks will have a hydraulic pressure of 1,000 psi and will be 16 in. in diameter.

The 20-ft tall vehicle will be driven under the launch platform on the high bay of the vertical assembly building in which the Saturn 5-Apollo has been assembled. Platform will be sitting on six steel pedestals 71 ft high. Jacks will engage the fittings on the pedestals.



ARTIST'S CONCEPT shows crawler transporting launch platform to be used with Saturn 5-Apollo vehicle. Crawler will use steel links, tracks, electric motors between front jacks and hydraulic jacks under each set of wheels.

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ABOVE: HELICOPTER ON BOARD



ABOVE: HELICOPTER NIGHTTIME

LEFT: HELICOPTER ON BOARD



ABOVE: HELICOPTER ON BOARD

LEFT: HELICOPTER ON BOARD



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## The Rocket-powered Northrop RP-78



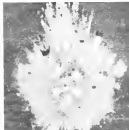
flies at Mach 1.3



operates at 65,000 feet



maneuvers by remote control



and gets blown up for its efforts.

The Northrop RP-78 target drone looks exactly like an actual launch vehicle raised on a roller system. The same altitudes, speeds, evasive action, and radar reflectivity that produce maneuverability are so common that it can be shot down at almost

**NORTHROP VENTURA**

of the platform and three feet the entire unit about 5 ft. to clear the pedestal. Cluster data will move the launcher embedded launch platform, with its Saturn V Apollo load, from the test launch assembly building to the launch stand on a two-hour, specially built rail car. Each launch will be 40 ft. wide and will be spaced by a 50-ft. wide trough. Crewmembers will stand by, at least 5 ft. from the launch.

### Platform Positioning

At the launch stand, the crew will directly observe the pads and allow the launcher embedded launch platform to rock down upon its steel anchoring pedestals. In addition, the stand also will be equipped with four extendable columns to adjust the platform against rebound loads in the event that the S-IC engines are shut down after ignition has taken place.

After positioning the launch platform on the stand, the crawler will move out from underneath and pick up the entire power. This will be a 475 ft. rail motor, with a 150 x 125 ft. base and a 50 x 10 ft. superstructure. From a location at the lower end of the installation of reentry, stage, engine, engine, and rocket packages, the task is considered to be potentially too big to be accomplished in the vertical assembly building. With its clamshell cocoon platform, the tower also will provide access to the rest of the Saturn V launch vehicle on its way to the launch pad. Tower also will have a stilling device crane in the top of the structure, capable of lifting 75 tons and of rotating through 370 deg.

### Arming Tower

The arming tower will rest on a platform inside to that of the launcher embedded tower. The crew will transport the tower from its parking area to the launch stand and dismount it next to the launch platform. It will contain three rail T-7s on the day of launch, when the crawler will return it to the parking area, some 7,000 ft. away from the launch stand.

There will be three launch stands, A, B and C, at Complex 39. Each will be about 8.5 km from the Atlantic Ocean and about 6,700 ft. apart. Each pad area will encompass a site about 4,000 ft. in diameter.

Stands already will be little more than steel and concrete foundations, with the launch operation will be conducted from the launch platform. Table surface of the stand will be 45 ft. above ground level. A mobile wedge-shaped stand three feet wide will be positioned on side 15 ft. launch. The F-1 engines of the booster stage, the booster, the edge of which will be made

## USAF Modifies Astronaut Training

Edwards AFB-U.S. Air Force has modified training courses and entrance requirements at its Aerospace Research Pilot School here to ensure its pool of candidates eligible for future astronaut training. First class under the new curriculum begins July 1 and is expected to train out to space-oriented graduates usually from those standing in line months later.

New, six-year curriculum is composed of a six-month experimental test pilot course (including four flight simulators) and a six-month aerospace research pilot course (including four years of research). Research, most pilots were required to have test pilot experience before attending the aerospace course; this requirement was waived for certain students, however, starting last November.

In stepping entrance requirements down 1,800 ft. per class (2,000 ft. total time) to 150 ft. in operation, but has strictly (including helicopters), in addition to performing test pilot experience, Air Force hopes to lower the average age of graduates to a 25.29 (see lead).

Additional 24 years of test pilot experience, following graduation, would bring the average age of Air Force's general astronaut candidates to 30.53 years. The number with the W-37 test average age of experienced test pilot age in the Air Force. Maximum age for entrance now is 32, compared with 35 previously. Candidates must also have a number of engineering degrees.

Age requirement for National Aeronautics and Space Administration's general astronaut course was set at 35 years, which said not more often eligible Air Force pilots because of age. Air Force also lowered its requirements to the aerospace course because of loss and up most available candidates from its inventory of test pilots.

An additional feature of the new curriculum will be testing in systems control and operations during the seven months of training. These Lockheed NF-104As, modified F-104As (AFM No. 15-17), have been ordered by the flight test center here for this job. The planes will be located in numerous altitudes of 40,000 ft. (125,000 ft. under standard atmospheric conditions) by a Rocketdyne AR-2 rocketable rocket engine.

Previously will be to test in the 1,000 to 4,000-ft. variable thrust rocket engine at 30,000 ft., after acceleration to high speed and initiate a pull-up to climb to altitude. As when pressure will be dropped prior to starting the climb, then one engine eventually is shut down at 75,000 ft. to prevent overloading. Afterburners blow out at about 67,000 ft.

Hydrogen peroxide reaction control system, identical to that used on the X-15, is to be tested during the six months of training. The engine is to be tested on the way down at about 50,000 ft. Two flights of the NF-104A, modified by Lockheed-California Co., will begin in August. At a possible influence to the NF-104A, Air Force is now writing specifications for another modified inventory aircraft, which would be capable of reaching 215,000 ft. altitude.

Additional aircraft used by the Aerospace Research Pilot School and their missions are:

- Two Convair F-106As to investigate variable stability.
- One Convair F-106A to study variable lifting rates.
- One McDonnell F-101A to test its adaptive control system. This aircraft will be used by the school to study variable stability.

of reference metal, will still have the weight of the U-shaped stand for the launch. Launch the launch vehicle, it will contain 35 ft. long by 55 ft. wide and 45 ft. tall.

Other features in the launch area will include:

- Fuel venting operation room. An underground 60 x 160 ft. chamber, two two-story structures will provide off-hand line connections between the launchers, launch pad, launch pad and launch control center. It also will serve as a distribution center for high-pressure gas and electrical systems and will contain electronic systems of the launch vehicle, spacecraft and launch platform for test purposes when the actual equipment is not present.
- Liquid oxygen storage tank. Each

stand will have a 550,000 gal. capacity liquid oxygen storage tank located 1,450 ft. from launch pad center.

• Liquid hydrogen storage tank. Each stand will have a 500,000 gal. capacity liquid hydrogen storage tank located 1,450 ft. from launch pad center, opposite the oxygen tank. Tank will be vacuum-jacketed and pressurized to 75 psi during transfer operations.

• RP-1 fuel storage tank. Each stand will have three RP-1 storage tank units with a combined capacity of 251,000 gal. RP-1 is used only by the S-IC; it will be pumped at 2,000 gpm during fueling. These three tanks will be 1,450 ft. from launch pad center, on the same side as the hydrogen tank. • Gaseous oxygen gas storage facility. Gaseous oxygen and helium will be

Figure 1 consists of five vertically stacked plots. The top plot shows a sine wave input voltage ranging from 0 to 100V. The second plot shows the output voltage of the transducer, which is a sine wave with a peak amplitude of approximately 100V. The third plot shows the output voltage of the transducer, which is a sine wave with a peak amplitude of approximately 100V. The fourth plot shows the output voltage of the transducer, which is a sine wave with a peak amplitude of approximately 100V. The bottom plot shows the output voltage of the transducer, which is a sine wave with a peak amplitude of approximately 100V.

Studies in this area only part of United Control's attending search for new standards of reliability and performance. Scores of checks, from design evaluation to postmarketing acquisition of every production component, insure you the highest quality in temperature control systems for muscle guidance components, medical diagnostic series, food processing plants and a host of other unusual aerospace and industrial applications. Whenever the solution to your problems means temperature, environmental, flight or propulsion controls, or accessory systems and equipment, call United Control serving American industry where reliability counts.

Saturn 5 Apollo will be ready for flight within three to five days after reaching the launch stand. Checkout and tests will account for the bulk of the time.

Three seats on the third rail outside located a combination of various critical subsystems from the launch control center: checkout of hardware; backup circuits to the central control; power station of Sals is 5 stages to flight level; propellant loading circuit; radio frequency; intelligence tests about systems checkout; and a simulated flight test. This last mentioned exercise will take a day, proceeding through a simulated countdown launch and flight. Compatibility with all Atlantic Missile Corps stations and integrated Mission Control Center (AWR Dec 28 p. 32).

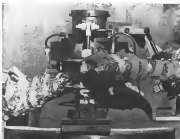
Houston, Tex., also will be visited on the tour.

Early on the day of launch, the starboard hypergolic propellants of the Apollo Service Module will be loaded aboard. Three propellants will feed the module's 22,500-lb thrust, storable engine, which will be used for midcourse correction during transference flight, de-orbiting into lunar orbit, course keep-

lunar orbit and nuclear reaction near during return flight to earth. At the same time, the hypergolic propellants of the S-4B's reaction control system will be loaded aboard.

Loading of onshore propellants will begin at T-7 hr on the launch day, beginning with the third stage and liquid oxygen first. Tanks will be pre-cooled, or chilled down prior to loading and new stages will be loaded in the lower

Each single unit is treated as 100 tons. Each tonnage is shifted. SIC will be shifted for 12 men and then loaded for 25 men at a rate of 1,000 gpm. with liquid oxygen. SIC at a rate of 1,000 gpm. will require 25 men, including 5 men for processing for liquid oxygen loading. SIC will be filled with oxygen at a rate of 10,000 gpm. and will re-



Classified nozzle for solid-propellant rocket thrust vector control has been tested in firing up to 185 sec. by Lockheed Pappalardo Co. Nozzle deflected subside rocket motor thrust 24 deg. in pitch and yaw. Compact, unit will weigh about one-eighth as much as fixed nozzles often used with comparable large thrust deflection. System uses deflected hydraulic oil, for operation of excessive momentous heating.

Liquid hydrogen then will be loaded aboard the upper stage. At a rate of

5,000 gms, the \$45 will take about 30 min. to fill with fuel, including time for shut down. At a fill rate of 10,000 gms., will take 15 min. to fill with liquid hydrogen including 10 min. for purging. Topping of both the liquid hydrogen and oxygen will continue until shortly before launch.

At T-4 hr, the chemo plots will enter their programmed mode. Insertion and wiring of the plots will require an estimated 115 min, and bring the count down to T-105 min. Now under the count will be devoted to final system checks.

At launch the FI engine in the S-1C stage will be ignited. The launch vehicle will be held by the hold-down support arms until sufficient thrust has been developed. A launch command signal will be sent from the launch control center and the joggle pins will be tripped allowing the S-1C to lift off from the rail.

SIC will burn for about 150 sec, reaching an altitude of 40 m and a velocity of 2,000 mph. S-2 stage then will separate and burn for about 500 sec. At burn out of the S-2, the vehicle should be at an altitude of 115 m and should have a velocity of 17,000 mph. S-4E third stage then will be separated.

Three 3-rodlets (AW Feb. 25, p. 27), consisting of a modified Tirtz 2 ICBM and two strap-on 120-in.-dia solid-propelled motors, will be assembled and checked out in a manner similar to that of *Robinson 3*. □

At Fort's equivalent of the vertical axis, the building will be the vertical irregular building. It too, will consist of a high end and a low bay area. The former will stand 237.5 ft. tall, 350 ft. wide and 100 ft. deep. The latter, or low bay area, will be immediately behind the high bay area and will stand 12 ft. high. It will be 310 ft. wide and 100 ft. deep, not including a 60-ft. deep, 50 ft. wide receiving and inspection station at the far end of the building.

The high bay area will include five bays in a side-by-side arrangement. Construction will extend through the length of the building, including the low bay area and will be used to erect the three stages of the Titan 2 core in a central position, preparatory to assembly. Two bays on either side of the aisle will be used for assembly of the stage case as integrated vehicle and each will contain



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5163 Series Ballistic-protected Harness Rest is shown in detail. The drawing shows the harness rest in its retracted position, ready for ejection. The harness rest is mounted on a base and is designed to automatically secure the pilot or astronaut to his seat and properly position him before ejection. The drawing is a technical illustration showing the mechanical details of the device.

an elevator. Low bay area will open into the back of the high bay, and also will be divided into two compartments—one corresponding to the high assembly bay and the other for center for receiving, inspecting and maintaining the stages at single units.

In operation, a transporter-launch platform—under the NASA's launchers—will be moved on air-rail tracks into one of the high bays. The platform on which Titan 3 will be assembled and later launched will be 68 ft long, 42 ft wide and 7 ft deep, and will be mounted on four speed-reduced rails, each capable of supporting 750 tons. Platform is made of steel, and will be built and mobile two solid propellant motor launch complex, one support mount and two launchers.

Four launchers, on one side, will be connected in tandem pairs to the aft end of the platform and lower launch and checkout equipment. The launchers are assigned to the launch vehicle and one to the payload. It will provide the platform into the vertical integration building and will be mounted into the low bay, immediately below the high bay where assembly is to take place.

When the transporter-launch platform is properly positioned the first step of the Titan 3 will be rolled down the center rail into the high bay, and set at a down on the platform. Several procedures will be followed with the second stage and runway. Work platforms will be lowered around the stages at this time employed. Platforms surrounding the spacecraft will be vertically adjustable to varying depths.

One 1,000-lb. load electric launchers in parallel will pull the assembled and checked-out Titan 3 core and the four ground support equipment from the vertical integration building onto a sliding where the three tons of the entire unit will be received. The locomotives then will push the platform and its cargo of a Titan 3 core plus checkout boxes into the solid motor assembly building.

Solid assembly building will be 218 ft tall with a base 174 ft wide and 118 ft long. The structure will provide the railroad tracks. Two low bay areas, each 158 ft tall with a base 150 ft wide, will flank each side of the high bay structure. Each low bay building will have a 75-ton capacity overhead bridge crane with a load height of 106 ft. High bay area will be served by a single 300-ton bridge crane with a load height of 190 ft.

Low bay cranes will pick up solid propellant segments and move them onto individual vertical assembly cells.

Each 55 ft long motor will be built up from five segments plus core and nozzle. After assembly and checkout of a solid motor, the 100-ton crane will place the motor on its supports, where it will be working on the center side of the solid assembly building.

Titan 3's solid propellant motor will be the C configuration. Titan 3 will flow with the motor only will be the A configuration. Titan 3's velocity will be around 10,000 ft/sec. The solid assembly building will be placed directly to one of two launch tracks 40 ft apart.

After picking up two solid motors, the locomotive will push the completely assembled Titan 3 to its launch stand, the entire complex being 8,000 ft long. The solid assembly building Launch stand will be 1,000 ft long. It will be little more than a handstand.

As the locomotive pushes the launch platform onto the pad, the two solid propellant motors will roll into a blow-and-ventilated building. This shock-resistant structure building will be 1,000 ft long and 100 ft wide. It will be able to attenuate the acoustic noise of the solid motor at launch to around 140 db.

A 750-ft tall mobile service tower then will be rolled up to enclose the Titan 3 and its launch platform, which will have been moved to the level surface of the pad. Locomotives will be disconnected and returned to the vertical integration building.

### Motor Exhaust

Platform will have a cutout in its center, like the Saturn 3's platform to permit escape of the first stage solid-propellant motor's exhaust. Exhaust duct will run at a right angle to the rail and turn 90 degrees for 15 ft before opening into the surrounding area. Launch for the long exhaust duct is to attenuate the acoustic noise of the solid motor—USAF and Aerospace will have a sound pressure of 160 db at exit in the open area, but no shaking wave of sounding it.

Railroad track system will consist of 7 mi. of two parallel standard-gauge tracks, one solid motor launch track and one solid motor launch track. The 27 ft 3 in. apart. Roadbed will be 21 ft deep. Missouri rail leads to the transporter-launch platform, carrying 500 tons including the weight of itself and a fully assembled but undrained Titan 3C, is estimated to be approximately 148,000 lb.

Digital signals will be transmitted from the ground support unit at the launch site to one of two chemical and electrohydraulic launch-control systems. Analog signals will be converted for transmission into digital form and later reconverted into analog form at the control center. Data required for post-flight analysis will be stored on tape to be read later.



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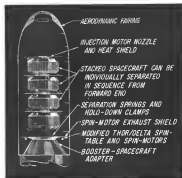
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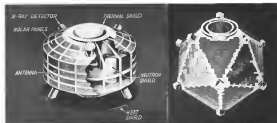
WE'VE OPENED A NEW FRONTIER THROUGH CHEMISTRY





## Vela Hotel Configuration Shown

Vela Hotel spacecraft is under the aegis of the Advanced Research Projects Agency and is being built by Space Technology Laboratories for detecting nuclear detonations in outer space (AW May 18, p. 36). Flight testing is scheduled to begin this fall. Spacecraft is a capsule protected with 20 inches. Solar cells cover the tetrapole surface. X-ray detectors are located at the vertices. Camera at right shows two Vela Hotel developmental spacecraft stacked within a glass fiber cone fitting on a two-stage launch vehicle. Now being a split lengthwise into a two-section clamped to facilitate getting away.



Camera (left) shows typical Vela Hotel spacecraft. At right, a wire's suggestion of spacecraft showing solar cell sensor

That's our P-200 platform on your lower right. In December of 1955, the first P-200 was delivered to Grumman for their E-1B aircraft as the heart of our LN-1A inertial system. The one above is our P-300, about one-half as heavy and not much larger than a football. Despite these reductions, the system provides greater reliability, maintainability, and accuracy. This miniaturized inertial reference platform was developed under an applied research contract with the Flight Control Laboratory of the Aeronautical Systems Division, Air Force Systems Command.

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# DOD Funds \$15 Million for Laser R&D

New York—Defense Dept. funding of laser research and development is approximately \$15 million with an additional estimated \$5-\$80 million of industry funded effort, Dr. Robert H. Kingston said here during a status report on optical matters by a panel of five experts at the Institute of Electrical and Electronic Engineers convention.

Kingston, a member of the staff of Lincoln Laboratories and chairman of a Defense Dept. panel of laser consultants (AW Jan 15, 1962, p. 82), said the government-sponsored laser research and development funds are allocated approximately:

- 25% Basic research in materials and components
- 5% Developing improved laser materials
- 40% Developing improved optical components
- 40% Developing new laser devices
- 20% Applying lasers to specific military equipment

Kingston predicted that the coming year would see at least a 10-fold increase in the output power level of lasers and as three spectrum which currently ranges from about 0.6 microns (red portion of visible spectrum) to 20 microns in the infrared region.

## Laser Advances

Dr. Charles H. Townes, who with an IEEE panel member, Dr. Arthur L. Schawlow, first proposed the optical maser, said that he has been very sanguine with the rapidly and variety of laser advances during the past year.

Kingston observed that many of these would have been impossible to predict a year earlier as indication of the speed with which the technology is catching up the difficulty of making sound predictions of future advances.

Kingston cited the following as examples of some of the more interesting two developments of the past year:

- **Raman laser**, built by Hughes Aircraft Co. in which the beam of a pulsed ruby laser, radiating at 7,414 Angstroms, passes through an organic liquid and produces a laser action after the liquid which radiates at a different frequency, ranging from 7,415 to 9,618 Angstroms depending upon the liquid used. The device effectively functions in a few quaker containers, with efficiency as high as 80%, Kingston reported.
- **Crystal resonators**, first demonstrated by Ford Motor Co. scientists in which a 100 Angstrom solid body, formed as a solid on end, generates a second laser beam laser at 3,500 Angstroms which emerges from the crystal. Com resonant efficiency is about 20%.
- **Gallium-arsenide semiconductor laser**, first announced by the International Business Machines Corp. and General Elec-

tric, shows promise of providing relatively simple, highly efficient optical sources. Dr. Kingston stated that when the current level in present devices gets too high, the gallium-arsenide laser modules at many frequencies and that considerable work must be done to scale up the device for moderately high-power levels.

## Laser Uses

Despite the fact that the first laser was reported less than three years ago, the new device already is finding a wide variety of uses, Dr. George Smith of Hughes Aircraft Co. reported. Some of the more promising cited by Dr. Smith included the following:

- **Microslicing**. Light is on the verge of having a practical device for cutting and welding extremely small objects, such as bonding leads to micro-circuits. Smith and Louis Benoit can deliver more energy in a laser beam than an electron beam, he said, with the important advantage that the operation need not be carried out in a vacuum as required for electron beam welding.

• **Laser radar probe**. Within a year the state of the laser art should permit its use as an earth-based radar which can make useful measurements of the structure of the lunar surface.

• **Botchicki range radar**. High-speed developed portable laser radar for increasing range of target is a half-mile (AW Mar 18, p. 55), roughly 40 ft, including a 100-mph range, and was demonstrated for the IEEE. The device uses a pulsed ruby laser with a peak power of more than one megawatt which produces range of up to 100 miles under ideal conditions.

• **High-speed photography**. Extremely short-duration, high-energy illumination from a pulsed laser using a Krypton fluoride high-speed shutter, provides continuous camera at photographing high-speed phenomena. University of Southern California scientists are using a ruby laser to study combustion and fluid flow problems with the University of Illinois researchers.

• **Medical**. Extensive research has been held on the use of the laser beam for cancer treatment. When French scientists were needed to prevent the patient from moving his

eye during retina surgery, the laser operates so quickly that its motion is arrested.

Despite a number of experiments which have demonstrated the apparent value of the laser for medical communications, Dr. Rudolph Kompfner of Bell Telephone Laboratories observed that its utilization may have been overrated for terrestrial applications where the laser beam must be transmitted through the earth's atmosphere.

Kompfner told the IEEE that Bell Telephone Laboratories had measured as much as 100 db attenuation of a laser beam over a distance of only 1,900 ft in a fog. The use of the laser for communications appears most likely to occur outside the earth's atmosphere.

Eventually there may be terrestrial applications using long concentrated pipes through which the laser beam will travel. But before such optical long lines are feasible it will be necessary to develop a whole family of components including such things as efficient modulation systems, narrow and transmission line optics, Kompfner said.

## Tough Competition

Townes expressed agreement that the laser faces tough competition from existing communication tools and that it would find use only when it can perform functions not now available or feasible with radio and telephone systems. One use was suggested by Dr. Kingston, who was specifically conspicuous through the plasma produced by crystals, which blocks out some of the frequencies, or for penetrating the last mile gap during landing of the Apollo. Lower frequency Mobile [LEMC] to use the laser as a radar alternative.

In response to a question by Townes as whether the laser would be competing directly with radio and telephone systems, Dr. Schawlow suggested that more effort was needed to apply existing low-level to operating systems. One example he cited was the need for more effort to scale up present lasers to higher power.

Replying to a question from the floor as to whether it would be feasible to convert atomic energy in the lab into power levels of more than laser beams, Dr. Smith said it was "pretty bleak."

He pointed out that with the enormous energy a present one megawatt laser could produce power in the megawatt range would be required, posing serious cooling problems.



## Compact, Comfortable... The New AO Hear-Guard Hearing Protector Provides Superior Performance

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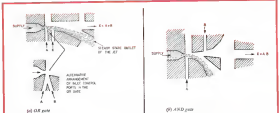
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**IBM CURRENTLY IS STUDYING** hydraulic logic elements which have no moving mechanical parts and depend upon movement of pistons with hydraulic fluids. In the OR gate (left), application of fluid control pressure (gate A or B) will cause gate to swing and allow flow to the AND gate (right), control valve at A and B simultaneously. This gate of only one gate will allow gate to exit at other gates.

## IBM Lab Taps European Science Skills

By Philip J. Klein

Zurich-International Research Machine Zurich (Switzerland) Research Laboratory gives the computer, a communications interface with the European scientific community whose efforts even stretch far beyond the borders of its staff.

The 24 professional scientists on the IBM staff here are an international group, representing Switzerland, Germany, Britain, Canada, Sweden, Holland, and India, and with student scientists arriving during the summer from Denmark. Most of the scientists here came to the IBM Zurich Research Laboratory from European universities.

This provides contact with many additional top European scientists in some instances the IBM Laboratory here carries out joint research with universities or with its customers. Each tries to support research of academic colleagues whose facilities are limited. For example, the laboratory here is collaborating with Paul Weiss Laboratory at the Munich Technical Hochschule on the preparation of thin films of micro-circuits.

The IBM Zurich Laboratory, directed by Dr. A. P. Sponer who came from the Swiss Federal Institute of Technology in Zurich research has moved into a new quarters in Zurich, a suburb of Zurich. Total employment is about 75, one-third of which are professional. Present plant cost for expanding the staff eventually to about 120 of which about 50 will be scientists.

The laboratory was organized by Dr. Sponer and opened in 1956 with a staff of five scientists.

Efforts of the laboratory are nearly equally divided between basic research and applied research, the former devoted to acquiring new knowledge

which has no obvious application to IBM's product line while the latter is centered in basic technology suitable for data processing. This is reflected in the background of laboratory scientists. About half are physically well trained, about half are engineers, about half are chemists, and about half are physicists. This is reflected in the research interests of the scientists who are generally theorists more rather than experimentalists.

Two of four operating sections of the laboratory are working primarily in applied research.

- **Thin oxide film applications**, under Dr. Gerhard Kohla, is seeking to improve the magnetic thin film memory developed here and marketed in February 1962. The memory of that time had a read/write cycle time of 100 nanoseconds (100 billionths of a second) and a capacity of 10,432 bits, the fastest memory of its size developed at that time.
- **Fluid dynamics**, under Dr. H. M. Glesler, is concentrating here and applied research in hydraulic and pneumatic computer elements and emphasis in the two basic research groups in the

laboratory are working in these fields:

- **Solid state physics**, under Clem Schuler, currently is investigating the optical properties of thin films of semiconductors which exhibit lensing-optical properties.
- **Magnetism**, Dr. Thomas is investigating basic principles of magnetism, probably in support of the thin film memory applications group.

Program is investigating hydraulic logic elements and one of the first projects related are years ago at the Zurich Laboratory by Glesler. A variety of basic computer logic functions were developed using thin film cantilevered piezoelectric elements. These exhibited response times of about one millionth of a second, enabling them to handle up to 100 pulses per second. Complete shift registers and binary counters were built using groups of such hydraulic logic elements.

While the hydraulic logic elements, like electric relays, are relatively simple and effective devices for performing computer functions, both suffer reliability problems because they involve many moving parts, according to Allan Mitchell, a British engineer in the fluid dynamics group here. To achieve rapid response, the hydraulic logic (pistons) was fabricated from lightweight plastic which proved susceptible to wear. This pistons and design resulting from such wear caused malfunctions in subsequent hydraulic relays by jamming their parts.

Several years ago the laboratory here shifted its efforts to hydraulic logic elements with no moving parts which operate by means of excitation between fluid jets and a stationary boundary wall.

These elements make use of the "Coanda Effect" in which a moving fluid tends to attach itself to an adjacent wall. Using this principle it is possible to fabricate a simple hydraulic jettable flip-flop, for example, in which an incoming fluid jet can be caused to exit from either of two output ports by applying a brief hydraulic control pulse at right angles to the jet. The fluid adheres to one wall and continues to exit from the selected output port and another brief hydraulic control pulse is applied which causes the jet to swing over and attach itself to the opposite wall cutting from the other output port.

Using this principle IBM has constructed an OR gate in which the pressure of a brief pulse of fluid at either of two (or many) control outlets will divert the jet from its normal steady state output port to a signal output port. With only a slight modification of jet wall construction, the device becomes an AND gate in which results require presence of pulses from two or more control outlets will cause the jet to swing and emerge from the signal output port.

Because of the many factors which influence the interaction of the moving jet and control outlets including such things as jet velocity, shape of the jet, jetting wall, thickness and depth of the fluid channels and the material properties required for control functions, a large part of the investigation must be carried out by experimentalists rather than by mathematical analysis, according to Mitchell.

Effect of these many parameters is being investigated using the fluid equivalent of a word tunnel in which flow of one color is used for the main jet while another is used for control outlets. This is adapted to a computer circuit in which the fluid jet is used as a part of the circuit.

The IBM scientists here consider that hydraulic or pneumatic computers are more likely to replace the electronic type for most applications. But this point out that the non-electronic type logic can be well suited for use in industrial or aerospace applications where breakdown or power loss would be a problem for the process to be controlled. One such application might be rocket boosters where the fuel could be shut off and compensated control prior to saving its primary function.

The 100 nanosecond cycle time response necessary achieved by the IBM Zurich Laboratory a year ago represented such a major advance in speed that it has not been easy to achieve further improvements. The laboratory is continuing toward that objective according to Dr. Kohla who directs this effort.

Some problems it will be much as the thin film magnetic cells themselves but

in the limitations imposed by the more rapid transistor circuits and to store and information out of the cells. While the present thin film magnetic cells themselves have a cycle time of only five nanoseconds, they can only be pulsed once every 50 nanoseconds to avoid overheating currents available high-frequency transistor used as drivers.

Because read-out of the present cells destroys the stored information which requires a second pulse to restore it, the total operational cycle time is 100 nanoseconds. Additionally, the current time of the transistorized unit available at least one time to about 100 nanoseconds, Dr. Kohla says.

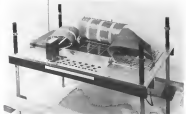
These factors are that the use of improved transistors and other techniques will make it possible to reduce the cycle time to 10 nanoseconds or less, he adds. Although the group of 14 elements called the "new cells" have long been known, until about 1950 these were only used as a model only in the form of a control concept for very expensive automatic quantities. For the most part the basic physical properties of these small cells are not known. The modern physical approach, as described by the group and presented by Dr. Kohla, is to use the same concept for the new cells. Dr. Kohla points out that the recent development of this high vacuum technique for making the pure micro-circuits and maintaining them free of contamination the normal opportunity which the laboratory has been exploring.

As students in beginning chemistry learn about the properties of the molecules, they are exposed to the molecules, they are exposed to the molecules, they are exposed to the molecules.

The new cells are grouped separately and apart from the molecules of the elements because they are chemical properties do not conform to the properties of the elements. While most elements have a chemical structure of elements and over their different individual properties in different numbers of elements in their other cells, the new cells have chemical structure of elements in the same shell but each has a different number of electrons in its outer shell. This gives each a slightly different magnetic property, rather than a different chemical property.

In an effort to learn more about the new cells, scientists themselves as well as to give a better insight into the basic mechanism of magnetism, which is never understood in the same way as the molecules, the IBM Zurich Laboratory has begun to probe more deeply than transparent films of some cells with light shining in a very length from a distance to indicate about its nature, Schuler says.

To maintain the cells in its unexcited form, the film film must be deposited in a vacuum chamber maintained at a pressure of 10<sup>-6</sup> mm Hg. Inside a thin film about 100 Angstroms thick, deposited and polished light at the selected wavelength is focused on the thin film while it is in the high vacuum, with micro-manipulators made to determine how much of the light is transmitted through the film and how much is reflected. Measurements are made across the spectrum and then an additional layer of the metal is deposited and the experiment repeated. This continues until the thickness of



**IBM'S ZURICH RESEARCH LABORATORY**, which ranks among the top European scientific research, developed technology for the experimental high speed thin film memory having cycle time of only 10 nanoseconds (100 nanoseconds). Each of eight systems yields can make 2,000 bits of information. Drawing and testing lines of eight super fast cells are made from thin magnetic film substrates to show construction. The Zurich laboratory also is active in hydraulic amplifiers and computer elements as well as conducting more basic research such as investigating "new cells" units.

the feed is built up to the point where it is a lower concentration habit.

In experiments to date, the laboratory has made such measurements on goldfishes, with the next experiments planned for robins. The experiment requires a month or more for each month's work.

Whether or not these new words will find any application in the field of computers or data processing is impossible to predict, the IBM scientist says. But it was the studies of basic properties of semiconductor materials at Bell Telephone Laboratories which led to the transistor. And if the IBM research here provides better understanding of

magnum, it was ultimately possible  
to establish constant parameters.

The scientists here are given wide latitude in their choice of projects, but in the local management and by IBM's Watson Research Center in Yorktown, N. Y., a freedom which is essential to creative scientists, according to Dr. Thomas. The major criteria is that the project be stimulating and important unexplored territory which will reflect credit on the scientist and the firm.

Skowron here who went from Europa University when asked how this life first new environment successfully respond by concentrating about the advantages of having the research facilities

They need a heavy net imposed on their former positions. Some say they need the opportunity to teach and the stimulation of working with persistent young students, but others resent in-school, short-term school of routine teaching duties to concentrate on research.

The establishment of research laboratories in Europe to tap its scientific knowledge is one means of avoiding the serious criticism voiced in Britain over the loss of scientists to the United States and recent attempts to recruit still more (AW May 25, p 100). An increasing number of companies are setting up such facilities in Europe rather than attempting to transplant research

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**FILTER CENTER**

• **New to Explore:** Next Decade's Animation Nip-T—aiming to develop a generation of animators, nature films will be made and an annual the New expo will be added to its fest during the decade from 1973 to 1983 will be started soon by the New's Bureau of Wapuna. An aim will be to use the resources such as water, steel, and soft substances, with very fine and soft warming materials. A special committee having experience in function integration, fluid motion, as well as design, style, and conceptual sustainability design, motion effects, news and streamers/other macroscopic as being sought in the West.

► **Computer Design of Microassembly:** Industry proposals for an Air Force development contract aimed at achieving completely automated production of microcomponents using computers for design and control are being evaluated by USAF's Aeronautical Systems Division. The immediate objective of the effort will be to come up with a technique enabling worker and microconnection needed in fabricating components to be designed in new ways.

Many Massachusetts Technological Resources, Inc. and National Semiconductor Corp., Danbury, Conn., have entered into an informal agreement to work together in developing hybrid microcircuits. National will supply Lisa Segler with semiconductor substrates for mounting components, which she will activate by depositing thin films of metal and a passivation layer. Lisa Segler will then assemble the puzzle from film components. The two companies had jointly on a recent Army microcircuit program, and were preparing together on similar future components. Lisa Segler is interested in acquiring a semiconductor capability to complement his extensive thin film facilities (AW Feb. 25, p. 97), but it remains to be seen how well the Massachusetts Semiconductor unit does if sold as separate units.

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KAMAN UH-2A SKULPTOR views and leaves helicopter body steeply during simulated rescue mission.

## Aviation Week Pilot Report:

## Kaman UH-2A Demonstrates All-Weather

By David A. Reuss

**Bloomfield, Conn.**—Maneuverability at speeds up to 150 kt, design limit, all-weather capability which permits near-landoff flight on landing approaches, and a Doppler navigation system to complement language capabilities are the outstanding features of the Navy's Kaman UH-2A (HUK-1) rescue and transport helicopter.

Now entering squadron service with the Navy, both on the Atlantic and Pacific coasts, the UH-2A demonstrated its performance during a recent flight here with the *Aviation Week & Space Technology* pilot flying from the co-pilot's seat.

The UH-2A demonstrated:  
 • Simulated striding nose where angle of bank exceeded 90 deg. during high-speed turns, no-rotor contact with an other helicopter, and a low-altitude high-speed run over a parallel highway followed by a pull-up into a high-speed climb.

• Forward Doppler navigation system designed to allow long-range navigation without reference to a ground station. System is completely automatic; AN APN-150 Doppler radar is built by Raytheon and the ASA-15A computer and FT-420 display board are built by Loral Electronics Corp.

• Instrument approach using automatic stabilization equipment and Doppler altimeter, which permitted the heli-

copter to fly close with hands off the collective control and with only trim adjustments on the cyclic. The helicopter automatically maintained a hover at 20 ft, then made a landoff (takeoff) maneuver. Planned originally as a high-speed, long-range rescue and rescue aircraft,

UH-2A Specifications	
Length overall	56 ft 8 in.
Maximum cruising speed	120 kt
Top speed	130 kt
Rate of climb	44 ft/sec
Height to tail rotor tip	14 ft 8 in.
Engine	General Electric T55-C6-1B
Max. speed	150 kt
Max. gross weight	10,000 lb

and later as an anti-submarine warfare helicopter (AWH) Oct. 26, 1975, p. 52), the UH-2A now is being pushed aggressively by Kaman as the forthcoming Army armed helicopter competitor (AWH) Feb. 18, p. 20).

The helicopter shows some good features of the UH-2A with fixed and Navy equipment aboard, including two 60-gal. external fuel tanks.

Two droolback tanks located beneath the main rotor contain a total of 275 gal. of fuel, of which about 275 gal. is usable. Of the 120 gal. in the external tanks, about 115 gal. is usable. This fuel gives the UH-2A an endurance of more than 1 hr. at maximum gross weight of 10,000 lb. and an endurance of 60 hr. at 7,000 lb. gross weight.

Kaman Test Pilot Alan Ashley flew on the right seat. Wind was 12-15 kt, from the west and it increased appreciably during the flight. Temperature was 41F and the dew point was 31F. Gross weight at takeoff was 8,125 lb., compared with a maximum gross weight of 10,000 lb.

The UH-2A takes only about eight up collectives to apply. You cannot be accomplished with the collective full down without tilting the rotor plane so far that the rotor head and mast could



UH-2A LANDS ABOARD the nuclear-powered carrier USS Enterprise. Note white landing field tails on the side of the helicopter.

## Capability, Maneuverability for Navy Roles

be damaged. With the collective used slightly, UH-2A is easy to control on the ground and easy to take off. Engine speed was set for flight by one of the thumb-lever-manometers; accuracy is 95% engine and rotor speed—and the UH-2A lifted into a hover with only a slight upward movement of the collective.

With blades fully bent on, the helicopter controls were exceptionally light and responsive. Initial landing was to check the helicopter with the controls, which seemed to be complete at first. By clearing control reaction, the pilot allows the helicopter to dump its own movements and it will hover steadily with little or no cyclic control.

Takeoff was made in the west. Because the UH-2A accelerates rapidly for a helicopter, it was somewhat difficult to estimate speed correctly. Frequent checks of the speed indicator showed the helicopter usually was traveling 120 kt faster than it appeared to be. Cost was attracted below the 60-kt reference markers. Actually, it may be safely attracted at speeds below 100 kt. New gear design permits higher maneuvering speeds.

With the automatic stabilization equipment (ASE) off, the UH-2A was

maneuvered at 100-120 kt for further action. Flight in cruise configuration was accomplished with the long-term altitude at 85 ft.

First impression of the UH-2A, designed by the Skulptor by the Navy, is that it has a high and comfortable operating speed with a noticeable lack of vibration, particularly at the higher end of its speed range. Speed of about 120 kt is where the helicopter seems to operate best at cruise, and it is quite comfortable to fly in this speed regime.



NEW LANDING GEAR design permits reduction at speeds of up to 100 kt. Auxiliary tank is hung on landing skids-type fittings.

Controls remain light all the way through the speed regime with least on. Don't off the controls are heavy, but not unusable. A slight bank was noted when the hover was lifted off, caused by the hydraulic actuator being shut down.

Minimum continuous climb was entered after reducing forward speed to about 60 kt, and the UH-2A climbed at 3,100 ft/min. Landing factor was below zero temperature, which was held in 6100.

After landing off at 2,500 ft, autorotation was entered. Airspeed was increased to more than 100 kt by lowering the nose and vibration level returned low.

During autorotation, the UH-2A showed a tendency to have a rather high rate of descent, although one autorotation was purposely made fast and the others were into a stalling speed.

Ashley selected a firm field—landed and with a nose-up attitude, the UH-2A's high-speed maneuverability with a series of simulated striding nose. First pass was made at approximately 170 kt, followed by a series of about 15 ft, followed by a series of about 15 ft, followed by a series of about 15 ft, followed by a series of about 15 ft.



## Itinerant tropo scatter systems

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The MRC-96 can currently deliver one relay 24 voice messages and 18 teletype messages at a time, by bouncing radio waves off the troposphere in hops of approximately 200 miles. It has the built-in capability of handling 60 voice messages and 48 teletype messages. This quadruple diversity

system is reliable 12 months a year, even under the poor atmospheric conditions of the winter months.

Principal components of the AN/MRC-96 10 KW system are the AN/PRC-99(V) man-to-man transmitter, the AN/PRC-17 man-to-aircraft, air-to-air signaling equipment, CV-566-GT, order-wire equipment, two 15-ft. parabolic reflector antennas, two 100 KW generators. It operates in the 750 to 905 mc band.

The system is compatible with the Defense Communications System long-haul network and offers an economical and quick means of extending communications to new areas. For more information on this tropo scatter system, and/or additional mobile or fixed ground stations for satellite communications, write in care of Government Marketing in Baltimore 4, Maryland.

**Bendix Radio Division**



the main field. Turn radius at the end of each pass was short and precise to the point where the first indications of ground appeared. Bank angles averaged 90 deg. Although the UH-1A had no gyrojet, a point on the ground could be held steadily with reference to the windward.

Low-altitude maneuvering was demonstrated by making a high-speed 140-150 kt. run through an area of broken woods, maneuvering through open cuts. Bank angles at turn approach of 60 deg.

Engine torque meter indicated 75 psi during portions of the demonstration, about 6 psi above the maximum for sustained operation, but 3 psi below the 10-sec. military rating limitation.

A high-speed, low-altitude run then was made in the Kansas experimental hanger heliport. Speed over the pad was 150 kt. and altitude was estimated at 5-8 ft. At the end of the pass, the UH-1A was pulled into a steep climb, trading speed for altitude and rate of climb reached 4,500 fpm.

Auxiliary UH-1A was encountered after climbout and a simulated dogfight run was made, approaching the second helicopter from its right forward quarter. The second helicopter turned right and dived beneath us and Aubrey coposed with a 150 deg. climbout here to the right, coming out about 100 ft above the second helicopter and sev-

eral hundred yards to his rear. Aubrey was closed in going into a shallow dive to pick up speed and evasive turns were countered by ranning inside their radius.

The second helicopter was near tree-top level which presented at first, dogfighting. Rapid visual maneuvers would have made dodging and diving difficult at higher angles, but usage eventually was closed to a point where these evasive maneuvers would have been of little value.

### All-Weather Demonstration

After following several turns, Aubrey broke away to the left and resumed to the left for a demonstration of the UH-1A's all-weather capability. ASE was engaged on a switch on the order control console. Amplifier of the ASE sensor search altimeter, unpowered, heading, altitude and groundspeed information and control inputs from bus switches and the pilot's light controls. It then leads inputs to the light control system through a hydraulic actuator to maintain unpowered or groundspeed, roll altitude and heading.

The system is effective at all altitudes and airspeeds, including hover. Once using the ASE system may be done by the pilot at any time without changing any of the wing light controls or bus switches.

Besides being able to select unpowered or groundspeed, the pilot may choose either the radar altimeter or the



INSTRUMENT PANEL of the UH-1A is designed for all-weather operation, with flight instruments grouped as best of each pilot. Tactical display, heading, roll, yaw, pitch, engine, gear, speed, etc. Note dog-plate shield. Collective band, visible over pilot's seat, has fuel tank from cockpit.

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#### American Gyro



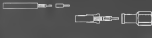
35,000+ hours' reliability on T-38 in flight!

#### Wisco Engineering



Simplify static testing with this new high-level transducer

#### Stoddard Aircraft Radio



Assembles in 45 seconds!

## Tamar: three typical contributions to electronics

Tamar Electronic Industries, Inc., is creating advanced electronic devices and systems for both industry and the military. Among the recent achievements of three of the corporation's divisions and subsidiaries are AMERICAN GYRO—provides Northrop's USAF T-38 supersonic twin jet trainers with stabilizer rate gyros which have achieved a reliability in excess of 35,000 hours in flight. MIANCO ENGINEERING—simplifies static testing with a high-level transducer which drives piezoelectric transducers, strip chart recorders, and automatic data systems directly. STODDART AIRCRAFT RADIO—offers the Tamar crewed machined 50-ohm micro-miniature connector which assembles in 45 seconds and requires no soldering of contacts. For more information about Tamar's wide-range capabilities in electronics, please contact Robert Gray, vice-president of marketing.

**TAMAR ELECTRONICS INDUSTRIES, INC.**

California Headquarters: 1302 South Los Angeles Street, Anaheim, California



Isometric altimeter to supply altitude information to the ASE supplier. Ashler flew a standard instrument approach with the radar altimeter engaged using the constant indicator on the radar altimeter to control a constant rate descent from 350 ft to 10 ft.

Turns were made by depressing the coordinated turn command button on the cyclic stick and then using the cyclic to bank the helicopter. ASI auto switches maintained a coordinated turn without need for radar pedal inputs, as long as the turn before was depressed.

Speed correction was made by simply tapping the pitch trim thumb lever on the cyclic and the helicopter was brought to a hover above the heliport. Collective control was not touched during the descent and the radar altimeter provided a smooth constant rate of descent.

Milking areas had caused the helicopter with a shallow pool of water. Since the Doppler radar failed to receive accurate signal returns from the water's surface, the helicopter had a tendency to hover to settle until the meter downstream disturbed the water sufficiently to provide an uneven surface for accurate radar returns. The ULTA then would climb to its set altitude where the downstream no longer affected the water and settling would begin again. This effect was not noticed when the helicopter was hovering over asphalt or other solid surface.

#### Radar Altimeter

Radar altimeters are most effective below 200 ft altitude and at speeds of 50 kt or less. Above 200 ft, its sensitivity is decreased to the point where it is not accurate. Planned speeds greater than 50 kt will introduce a false climb signal into the Doppler radar at turn and cause the aircraft to fly below its set altitude. This is inherent in the design and was not the result of an act of adjustment set.

Groundspeed information comes from the helicopter's Doppler radar system was derived to allow a heliport as a phase guidance reference to follow a steering course at a fixed speed, regardless of changes in wind velocity.

With the ASE engaged, one turn switch located on the collective head, can be used to make minor changes in direction amount about 3 deg or less. Normally it is used to change turn times on the radar pedal. These focus on the pedal are increased and automatically, if the helicopter is making a heading change of less than 90 deg with 3 deg per second. Movement of the pedal with ASE engaged will disengage the heading lock signal being received from the gyro compass.

After coming to a hover at the end of

the approach takeoff was made by changing the pitch trim to ease down attitude, allowing the helicopter to build up forward speed and increasing the altitude command set into the radar altimeter. UH-1A climbed out to 100 ft altitude at a slow but constant rate climb.

Accuracy of the all-command Doppler navigation system was displayed by setting the indicator bar a small amount of light extending in error, which shows heading on the rotor indicator at the center of the tactical display plotting board.

Information is transmitted to the computer group of the system from the Doppler radar, the gyro compass and the assigned indicator. By correlating information from the three, the system gives the pilot information on wind direction and speed when he is without visual reference.

For about 30 miles the helicopter was flown without reference to the navigation system, during which time some

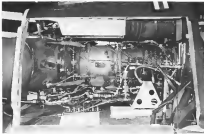
high-speed maneuvering was done, with rapid climb, descents.

Later, the helicopter was flown with reference to the navigation bar alone until the bar was centered on the rotor. Helicopter was over the original starting point. Even if any, was too small to be detected with the eye.

#### Display Board

Three series may be selected for the display board—10, 25 and 100 knots—and the grid system which divides the board into 10th inch vertically and horizontally, may be rotated through 360 deg. Bar can be moved to any starting position, so that the helicopter can be flown with reference to a map marker. Bar also can be used to hold its position.

If the Doppler radar information, or if a good source is not accurate, the system will update from memory of the last good signal and a warning light will inform the pilot of this. It is not then manually introduced wind and drift





## 2 more ways to measure with CEC



You get twice the bandwidth capability of conventional systems at equivalent speeds with two other CEC wide band tape systems, the VR 3000 portable and the VR-2800. Bandwidth of direct recording/reproducing is 100 cps to 200 kc. Or to 20 kc with wide band FM techniques. They are designed to fill gaps between the workhorse 100 kc models and more sophisticated machines. Solid state for greater inherent reliability, CEC's VR 2800 and VR-3000 feature a minimal DMA risk mounting and can be used in the lab, van, ship or blockhouse. Both systems are available for 7 channel (9" tape) or 14 channel (1" reel) operation. Interchangeable electronics make economy in support simpler.

Further data? Call CEC or write for Bulletin 3600-923 and 3300-416.



**CEC**  
CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of Bell & Howell • Pasadena, California

information to measure accuracy. Magnetic saturation information is normally extracted manually. System works about 10 cps maximum rpm.

Kaiser considers that the main pricing problem is the development of high speed interception in the utilization of vibration, particularly at higher air speeds and the XC-142's convertible free air vibration, especially above 180 kt.

### Foldable Rotors

Free-Matrix foldable rotor system has an automatic blade tracking system to keep blades on track during flight and if winds or eddies vibrations caused by out of track blades. If the automatic system malfunctions, blades can be tracked by the pilot from the cockpit or by the blade's own blade tracking and differential cone tracking system, he says.

Blade tracking control panel is located on the cockpit overhead and can control either C or D blade, single up or down or B and D blades collectively up or down. Block A is the master blade and remains fixed. Blades on lateral channels. Guard cones, designed to the tracking system of the vibrations caused by the blades being out of track control tip.

One blade was actuated during the flight with the manual system until the vibration was quite noticeable in the cockpit. Automatic system was then turned on and vibration was quickly

reduced to normal, or very nearly negligible.

Blades attempted to decongest the system by working the cuffing up and down to produce a strong out of track vibration but the system detects only vibrations on the frequency of one per rotor revolution, and it was unable to find the right frequency.

System operates only when weight is off the landing gear and when the air speed increases to more than 70 kt. It is shut down if the airspeed is decreased to less than 25 kt.

### Main Rotor

Main rotor is composed of the rotor hub, free blade vibration assemblies and free blades with flapping and leading lags. Leading lags have bi-directional dampers. Flap is held in the down position. Rotor tip speed is about 600 ft/sec at 108 ft rpm, or 276 rpm.

Blades are constructed of aluminum alloy spar with glass-fiber ribs at the trailing edge, and glass fiber covered honeycomb blade profiles. Blades have no electrical or air system.

Blade flapping is manually done. Six ft. leading device, located each blade and allows it to swing back to the folded position. Blades do not rotate about their longitudinal axis when they are folded so that there is relatively little chance of them being caught by the wind.

Final demonstration was a measure



### XC-142A's Engine Attitude-Tested

General Electric T44GE-6 turbofan engine scheduled for installation on the X-142A. The engine is a V-14, p. 141 has been tested over a range of attitude angles at the CEC test site at Fort Belvoir, Utah. Design angle range for the engine varies from 180 deg. nose up (below the horizon) to 45 deg. nose down. Engine is rated at 2,800 shp. It will be installed on the XC-142A.

## Who's delivering 1.5 mc recorders to working specs?

(CEC. That's who)

Here's the list 1.5 mc recorder sold to working specifications—CEC's VR-3600. This means specs that are produced from the time development of the tape system, not with repetitive adjustments before each test.

It's been proven with unit's built and delivered to quantity.

And the VR 3600's outstanding specifications make it a "zero-chance-of-failure" system, with performance superior to any comparable instrument in the extremely wide bandwidth multi-channel field. Each of the unit's 7 or 14 recording channels can be used for data storage in the

120 kc to 1.5 mc frequency range, with high signal-to-noise and low distortion characteristics.

The driver system has a full 14 mc bandwidth, fully amplitude and phase equalized with less than 2% harmonic distortion. No intermodulation product exceeds 0.75%, and phase response is held to within 0.2 sec.

In the tape transport, skew is under 30 msec, jitter is less than 0.005 g-p of 120 g pulses is constantly directed by a vacuum ionization device, and tension is held uniformly constant by a closed loop servo.

Contact your local CEC sales representative, or write for Bulletin 3600-910.



**CONSOLIDATED ELECTRODYNAMICS**  
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## FENN COMPLETENESS

Fenn offers you more than high gear design enabling you to meet your customer's control. You get the wide selection, location and experience that Fenn Completeness provides...and from this full capability for meeting your most demanding specifications and delivery schedules. May we tell you more about our Completeness service as well as our products and equipment?



THE FENN MANUFACTURING COMPANY  
FENN ROAD • NEWTON, CONN.



## EC-121K Modified for Ocean Research

Lockheed Navy EC-121K Super Constellation, modified by Lockheed Aircraft Service Co., will be used by the Naval Oceanographic Office. Aircraft will be used to collect data at part of a school of studies which include oceanic waves and sea state. Aircraft will carry an infrared sea surface temperature measuring device, an aircraft capable hydrographic package, wave height indicator, radiometer and temperature-pressure-humidity sensor.

loading at about 70 kt to show high-speed ground characteristics. Helicopters touched down gently and rolled into taxiway from across the paved airport before being lifted off again. Landing gear skidded the tracks during the roll-out and there was no noticeable bouncing.

Concept of the UH-2A is envisaged for instrument flight, with a large glass shield placed over the instrument panel.

Flight instruments, including gyro attitude indicator, dual needle radio magnetic indicator (RMI) and radio altimeter, are grouped in front of each pilot's seat. In addition, the pilot's right side has dual DME, groundspeed, drift angle, groundspeed direction-velocity (GSDV) and TDS indicators.

Engine gauges are centered above the throttle thrust display, giving board and each pilot has an individual engine temperature.

Control console contains various meters, landing gear, parking brake and emergency service handles are located along the right side of the console. Cabin overhead panel contains circuit breakers, warning light panel and various other switches. Tail wheel lock lever and rate brake are positioned to the right of the overhead.

Start procedure is similar to other turbine-engine helicopters. Rotor brake is played in and tail wheel locked in a turn and left position before engine start. Control levers, light switches, hydraulic system generator, fuel system, emergency switches and landing gear control compose the front cockpit left.

Thrust grip (throttle) on the collective is located to the left of the starter trigger located on the underside of the pilot's collective is engaged.

When the gas producer section of the General Electric T35-420-4B turbo-shaft engine reaches 15,200 rpm, the twist grip is rotated to the idle position. Igni-

tation should occur by the time the gas producer section has reached 13,500 rpm. Starter should be released by the time the gas producer section speed is up to 4,075.

Rotor brake interlock prevents the throttle from being placed to the fly position before the brake is released. Once the engine has advanced to 9,000 rpm, it is controlled by a thrust switch (throttle) on the collective hand.

## AFOSR Awards

Air Force Office of Scientific Research recently awarded grants and contracts totaling approximately \$4.5 million to universities and research firms in the United States and Europe.

**Contracts:**  
General Research Institute, Detroit City, Mich.—\$1.5 million for research on optical fiber of optical media.

Aeromedical Research Association of Princeton, Princeton, N. J.—\$1.1 million for the development of a new type of aircraft.

General Advanced Laboratory, Inc., Princeton, N. J.—\$1.1 million for investigation of high temperature phenomena in aerodynamic flow.

Marine Research Corp., Baltimore, Md.—\$1.0 million for investigation of effect of human environment of mechanical behavior of materials.

General Chemical Corp., Danbury, Conn.—\$1.0 million for research on submicron-scale chemical reaction.

Electro-Optical Systems, Inc., Princeton, N. J.—\$1.0 million for study of optical properties associated with manufacturing processes.

Acoustic Development, Inc., Long Island City, N. Y.—\$1.0 million for research on acoustical phenomena in aerodynamic flow.

Robert Power, Inc., New York—\$1.0 million for investigation of chemical reactions with microsystems.

Acme Corp., Mount, Conn.—\$1.0 million for research on the effect of microsystems on the effect of microsystems on the effect of microsystems.

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## FROM CHIP LOG TO ACCELEROMETER



Chip log (15th Century)—The oldest device known to measure a data speed. The chip was attached to a log barrel of specific intervals and drove through the water. When a wave crest passed, the log barrel was then counted, indicating the normal rate per hour the ship was making.

## ACCURATE, RELIABLE COMPONENTS DELIVERED ON TIME, AT LOW COST

AC develops and produces precision and aerospace components as well as complete navigation systems. AC aided in the development of, and is now producing, precision navigation systems and inertial reference integrating gyroscopes for the Navy's POLARIS Missile Program. In addition, AC produced gyros and accel. accelerometers have provided the heart for such AC guidance systems, including the A-10's Guidance Systems for the TITAN II, THOR and MAZC. AC produced instruments will be used in the development of an inertial platform for the APOLO spacecraft and a guidance system for the TITAN II.

Our record proves our ability to develop and produce precision guidance system components and to deliver them on time, at low cost. We welcome the challenge to prove our capabilities and solve your guidance problems. Contact Director of Sales, AC Milwaukee.



## MASTER NAVIGATORS THROUGH TIME AND SPACE

AC STARK PLANT • THE ELECTRONICS DIVISION OF GENERAL MOTORS  
7201 South Street, Milwaukee • Wisconsin

AC ACCELEROMETERS—These extremely accurate instruments measure the linear acceleration of objects, aircraft, ships, vehicles and aircraft vehicles and convert this information into velocity data. This and other integrated data are compared to the vehicle's position and velocity, giving any deviation from the intended line of motion.



## We are heavily involved in exotic instrumentation.



### A case in point is life support.

In our work to sustain human life in earth orbit, deep space and other hostile environments, we meet these upon the best capabilities to measure, design and produce a unique array of life support systems and environmental.

The knowledge and experience we have accumulated in the fabrication of breathing oxygen pressure control and supply equipment over the past 30+ years has led, in turn, to these current developments: supervised cryogenic atmosphere supply systems; pressure control equipment; temperature and humidity control devices;

some gas removal units and steam turbines air blowers. Systems designed and manufactured by us are in aerospace flight use as well as in home, automotive, underwater and other hostile environments that utilize many combinations of our design, development and production abilities.

In addition to life support, we are involved in oxygen, preflight environment and control, precision special-purpose electronics. We would be pleased to help you solve your particular instrumentation problems; just write us at Dept. APR in Downport, Iowa.

Pioneer-Central Division



in space and atmospheric flight. Warner and Co., Washington, D.C.—\$15,441 for study of laminar flow over curved surfaces.

Wright Technology, Inc., Dayton, Ohio—\$2,500 for study of vibration and structural dynamics in vehicle manufacturing. University of Wisconsin, Madison—\$17,400 for study of properties of earth in test devices for aircraft landing systems.

University of Illinois, Urbana-Champaign—\$2,000 for investigation of the aerodynamic behavior of the laminar flow of air.

University of Southern California, Pasadena—\$12,100 for study of aerodynamic behavior of aircraft in flight. University of Southern California, Pasadena—\$12,100 for study of aerodynamic behavior of aircraft in flight.

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### How is this reel used by American Airlines?

This is a standard reel and frame, electric motor and gear to handle reels for all aircraft. Reels used by American Airlines are used for loading, unloading, and automatic film production, with a motor and reel assembly, through the action and motion.

MADE BY HANNAY

Our 1964 Year  
CLINTON B. HANNAY & SON, INC., WESTFIELD, N. Y.

### PROBLEMATICAL RECREATIONS 165



The planet Decca is divided into eight continents, each occupying an action. Other earth countries border these cities. In how many ways can a traveler visit each of the other seven continents and only once, returning to his home country only at the end of his trip?

—Continued

Coupling specifications and photographs covering 200 problems (40 are new) are included in a new, quick reference catalog from our Elastic Tube Division. You'll find undrained restraints, struts, TWTs, microwave wave tubes, M-WFO's beam twisting tubes, crossed field amplifiers, CRTs, flow rate tubes, power supplies and related equipment. Ask for this 36-page 1963 Summary of Products and Review of Capabilities from the Marketing Department, 900 Industrial Road, San Carlos, Calif.

ANSWER TO LAST WEEK'S PROBLEM: The smallest integral solution satisfying the given conditions is  $a = 25$ ,  $b = 16$ ,  $c = 20$ .

LITTON INDUSTRIES, INC.  
Beverly Hills, California

# ABLATIVE ENGINES

## DURABLE, THROTTLEABLE, LIGHTWEIGHT



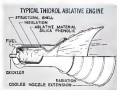
Performance proved above 97% theoretical in multiple tests by Thiokol

Using advanced injection techniques, plus the newest rocket-engineered chamber materials, Thiokol is making significant progress in ablatives technology.

One ablatives engine has already been fired over 145 minutes. Another—on ultra-lightweight space vehicle throttleable over a 40:1 range—was successfully tested at chamber pressures and combustion temperatures of actual lunar operations. Both engines remain suitable for extended service. Ablative tests are exceptionally low and performance consistently above 97% theoretical.

Their unique throttling injector—providing maximum propellant conversion, mixing and combustion stability—delivers high performance durability. There is no chemical or structural structure of the ablatives base.

The Thiokol engines are 20% lighter than comparable ablative systems of conventional design. Ablative—a durable, low density insulating material developed by Thiokol—saves many extra pounds in engine weight.



**Thiokol**  
CHEMICAL CORPORATION

Rocket Operations Center: Ogden, Utah  
An Equal Opportunity Employer



Graduate DSN-3 vehicle controlled with autonomous helicopter recently completed operational evaluation flights at sea aboard the destroyer USS *Black Point*. DSN-3, part of Navy's DASH (Destroyer Anti-Submarine Helicopter) program is equipped with two homing torpedoes.

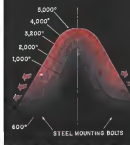
## DSN-3 ASW Helicopter Completes Destroyer Tests

Helicopter is controlled from two stations aboard destroyer. ASW vehicle is controlled back to ship by radio; visual contact is made.





**SOLID PIECE OF PYROLYTIC GRAPHITE** (left) was formed without a mandrel by Space Age Materials' plasma spray process. Thickness of conventional vapor-deposited pyrolytic graphite has been limited to under 11 in. plates and less to curved structures. Pyrolytic graphite now one eighth" imposed by Space Age Materials for Boeing's X-20 program would have slices 41 in. thick with heat conducting planes directed outward toward the base. Thickness of the structure and direction of heat plane would allow tailoring with steel bolting.



## New Pyrolytic Graphite Formation Method

By Ward Wright

New York-New concept in the formation of pyrolytic graphite structures which could allow nose cones, thrust nozzles, and hypersonic leading edge designs extreme flexibility in directing heat flow is being evaluated by Jet Propulsion Laboratory, Monroeville Corp., and Algonquin Electric Laboratory.

New method involves formation of pyrolytic graphite structures with heat-conducting planes tailored to the specifications of the designer. First solid pregraphitized but firing hot mouth of a small pyrolytic graphite thrust nozzle made available in the new technique was successful. The firing, in one of the configurations, lasted 40 sec and reached 1,700° after which no thrust erosion was found. The pyrolytic graphite material, called "Spined," is manufactured by Space Age Materials Corp. Inc.

Pyrolytic graphite's directional heat-conducting property stems from the high degree of anisotropy of its crystal lattice. Thus its crystals of pyrolytic graphite are aligned as layered parallel planes like plywood.

Heat flows easily along the planes due to the tightly bonded atomic structure in that direction. Between the planes where attractive forces are weak, heat flow is severely restricted. At right angles, pyrolytic graphite has great tensile strength along the parallel planes and great compressive strength across the planes, while longitudinal compression

of the planes causes fracturing and buckling.

Because of graphite's graphite's properties of being an excellent heat conductor in one direction and a very poor one in the other, and its strength above 5,000°F. the material offers designers a means of channeling heat away from such hot spots as solid-rocket throats and nose cones with a nonadjustable weight saving and better heat distribution than with metallic or composite metal-ceramic structures (AW Feb. 13, 1966, p. 67).

Several problems have restricted design and kept the material from reaching its full potential, however. To date there are no operational flight systems employing pyrolytic graphite in either nozzle or nose cone applications. However, a continuing, and efforts are being made to eliminate these problems.

Progress has been made in identification of the causes, direction and magnitude of thermal and residual stresses peculiar to pyrolytic graphite. Recent achievement centers around design to take advantage of stresses to provide structural integrity or to avoid harmful stresses.

Conventional vapor deposition method of forming the material imposes a further design restriction. In vapor deposition, pyrolytic graphite is deposited in parallel planes on the inside or outside of a mandrel by decomposing a hydrocarbon gas at temperatures of

1,500 to 2,000°C in a vacuum furnace.

Mandrel usually made of conventional graphite, determines the direction of the heat-conducting planes and the shape of the deposit. The mandrel either shrinks from stresses during the deposition process, or has to be isolated from the pyrolytic graphite structure.

Despite progress in stress analysis, quality control and elimination of flaws, present thickness of commercially available pyrolytic graphite formed by the vapor-deposition process is less than 11 in.

Space Age Materials' president, Michael Tuckert says that his firm has developed a proprietary plasma-spray process to form pyrolytic graphite structures. Tuckert says the process, developed with \$150,000 in company funds over the past three years, represents a complete departure from the vapor-deposition method and can control these characteristics of pyrolytic graphite.

Thickness pyrolytic graphite structure can be formed in any thickness, Tuckert says, limited only by the size of the plasma-spray equipment. To date, the largest single piece of plasma-formed pyrolytic graphite is about 7 in. in diameter. Since the plasma spray process does not necessarily require a mandrel, it is possible to machine structures from solid chunks of pyrolytic graphite if so desired.

• **Control orientation.** By not being

## Evaluated

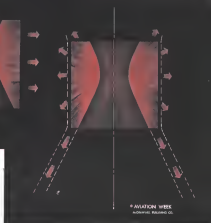
**NOZZLE CONSTRUCTED** from a stack of bonded or laminated pyrolytic graphite with an oxidized heat shield plate, has been tested with good results. Heat flow is solid.

achieved dependent on a mandrel for crystal orientation and shape, Tuckert says, the plasma spray allows planes of crystal lattice to be deposited in any direction desired.

• **Strength between planes.** Tuckert says his process can be altered to form a "lock-in" effect between parallel planes of pyrolytic graphite. This not only reduces the tendency to delaminate under stress. The lock-in effect is achieved by forming the crystalline planes in an overlapping "S" pattern. Since the parallel planes overlap, the material's tensile strength is converted across the planes to avoid delamination.

• **Aligns.** Methods such as boron, tungsten, hafnium and others can be aligned with plasma-formed pyrolytic graphite in graphite structures throughout the structure, according to Tuckert. While this capability exists with vapor-deposited pyrolytic graphite, he says the techniques now available should give designers more freedom in capitalizing on the advantages of these promising materials.

• **Stresses.** Plasma-formed pyrolytic graphite is subject to the same stress problems associated with the vapor-deposited material. However, Tuckert says his firm, like others, has learned to measure the effect of stress through design. Additionally, various pyrolytic graphite structures formed by the plasma method should be better equipped to sustain the effects of stresses than the thinner structures formed by



**CROSS SECTION** of a one-piece plasma-formed nozzle, oxidized heat shield, shows heat-conducting planes directed toward the skirt, cooling and from the throat. Design gives better heat distribution and eliminates bending problems of the metal stack design.



**ALTERNATIVE CONFIGURATION** one-piece nozzle formed by the plasma spray process has concentric heat-conducting planes which tightly follow the shape of the structure. Heat flow is primarily toward the skirt and throat. Skirt thickness is about 1 in.



## New calcium aluminate domes and windows for infra-red use!

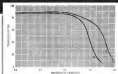
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### Soviet Gunboat Fires Anti-Ship Missiles

Soviet Kaman-class patrol ship shown firing missiles in test conducted in the Soviet Union. Gunboats are equipped with two missile launchers. Missiles have a range of approximately 11 mi., and are used primarily in attacking weapons. The same type of gunboats were reported active in the waters around Cuba (AW Feb. 15, p. 11).

the vapor-deposition process, according to Turek.

In typical nozzle applications, vapor-deposited pyrolytic graphite is used in one of two ways. First method consists of coating a conventional graphite nozzle liner with pyrolytic graphite. Heat flux is mainly toward the top and bottom of the nozzle, as dictated by the aerodynamic.

Throat area cooling and deflection from have been common trend in this design with the bond between the conventional and pyrolytic graphite due to the different expansion coefficient of the two materials.

Another approach is to deposit pyrolytic graphite on the slush, cut it into washers and stack it into a structure from which a nozzle can be machined.

### Atlas D Phaseout

Atlas D, earliest deployment of U.S. version of ICBMs, a program to be phased out at the operational level by the end of 1965 as solid-propellant Minuteman missiles are built up to replace them.

Probably is the final phase of the Atlas D will be followed by phaseout. In the end of 1967, of the semi-hardened Atlas E, and both the hardened Atlas F and Titan I, which have to be used from then on in the future for launch.

This would leave Minuteman and Titan 2, both launched from hardened silos, as the U.S. ballistic missile force.

Problem here is in building the washer stack together during firing. Washers have been bonded with an adhesive and fired with good results.

Present approach is to combine adhesive bonding with bolts running through the washer stack. Bolts could be welded in elongated mounting or obtuse slits to protect them from heat.

Advantage of the phase-deposited washers used in the washer stack concept, Turek says, is that the lowest structure can be achieved from one massive piece of pyrolytic graphite, eliminating adhesive bonding at joints and the necessity of bolts running through the stack.

Also, the best conducting places in the glass-former nozzle can be directed toward the slush, cruing and radiating from the throat for better heat distribution. That face in the washer nozzle is provided in a radial direction from the throat.

New ones recently proposed by Space Age Materials for Boeing's X-70 (Centauro) boost glider would consist of a solid pyrolytic graphite hollow cone 16 in. thick at the base and about 11 in. high, formed with pyrolytic graphite 40 in. thick.

Heat conducting plates would taper back from the apex, parallel with the cone, to a spot 4 in. from the base. At this point the heat conducting plates would curve toward the outside of the cone, in radially heat into the atmosphere.

Cone would be held in the back by

with steel bolts. Small, conical pyrolytic graphite plugs, with heat conducting plates extending from the apex to the base could be mounted between each bolt and the outside of the cone to conduct indirect heat away from the bolts.



### Decantamination Unit

USAF is using portable decontamination systems at its F-4B Base, 447 T-28 in use when launchers make propellant no longer that manufactured by Spadaco Co., Waukegan, Ill., is supported from a trailer frame.





## Colossus.

This is an aircraft bearing gear for a 5000W radar antenna installation. It measures two feet, eight inches in diameter.

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## PRODUCTION BRIEFING

Bender Corp.'s Mechanics Div., Mechanics, Ind., has been awarded a \$2.5 million Navy contract for research and development of the medium-range, sea-to-air Tighon missile system, which will be the next generation missile system for fleet defense.

Ralph M. Parsons Co., Los Angeles, Calif., has been awarded an architecture-engineering design contract from North American Aviation's Space and Inhabitation Systems Div. for the Apollo Lunar Test Facility at White Sands, N. M.

United Technology Center, Sunnyvale, Calif., will conduct laboratory scale research on combustion phenomena of berlium under a \$46,000 contract from Air Force's Office of Scientific Research. Program will include burning of aluminum and berlium vapor in various oxidizing gases.

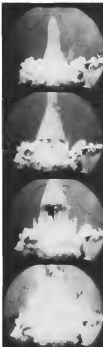
Radio Corp. of America's Data Systems Div., Van Nuys, Calif., will build 140 chassis for use in Minuteman's D-17 airborne digital computer. Work is financed by a \$1.5 million contract from North American Aviation's Aerospace Div.

Northrop's Vought Div., Northrup Park, Calif., has secured a \$5,305,000 Navy contract for production of 40 KIDNEY radio-controlled target drones for use in anti-aircraft gunnery and surface-to-air missile training.

Meritt Electronics Corp., Great River, N. Y., has secured a \$5.6 million Navy contract for continued production of the Meritt-developed Batup micro-wave radar.

Elgin National Watch Co. was selected by North American Aviation Space and Inhabitation Systems Div. to design, develop and produce an electronic mechanism timer for the Apollo spacecraft. The timer will synchronize spacecraft electronics and provide time pattern for the aqueduct. Award of the contract currently is under negotiation.

Sperry Rand Corp. will deliver the first of two advanced stage water-immersion ships (ARIS) to USAF late this month for Atlantic Missile Range missile tracking and simulation recovery experiments in the Indian Ocean. Completion of the 14,000-ton Wulff Wai 2 transport took 22 months. Second ARIS will be study in about three months.



**Polaris Launch**

Underwater separation photos show elevation of Polaris test ballistic missile from launch tube of the USS Thresher (numbered off Florida). Missile rose once oxygen kept from the submarine, so bubbles follow the missile (below).

## TARGET TODAY AT PDE.



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McDonnell F3 carries Earth KD2B-1 target under port wing to 35,000 ft for launch down Pacific Missile Range during qualification tests.

## Carrier Tests Qualify KD2B-1 for Production

Rocket-powered Beech KD2B-1, Mark 2 plus Navy and USAF target system is in final tests producing following extensive carrier compatibility trials. Final tests of the production order, which totals 500 systems, will be delivered beginning this month and will enter fleet service this summer. Total contract value, including research and development and production through December, 1968, is estimated at \$30 million.

KD2B-1 is designed as a superior target system which can be carried anywhere in the world by Navy carrier units for positive operations. The system has been certified from Mark 0-4 through Mark 2-17 and for altitudes between 3,000 and 75,000 ft. Possible future studies would be aimed at extending performance envelope to speeds above Mach 3 and altitudes from 230 to 90,000 ft.

Carrier suitability trials included tests at Naval Air Test Center, Patuxent River,

MD, where the KD2B-1 was fitted to a McDonnell F3 (F4H) aircraft and tests performed, with the airplane then making severe carrier-type arrested landings in oceanic conditions. The aircraft flew three times and stopped the end of the arresting cable hook during the tests. Checks showed the target system in a "go" condition after three runs.

U.S.S. Trawavenger was used in trials of handling characteristics on the ship and off the flight deck. Because the target measures only 162.67 in overall and has a maximum width of 38.12 in., it can be hoisted through the ship without disassembly. Storage is facilitated by the KD2B-1's use of pre-packed rigid propellers. Tanks are fueled at Beech Aircraft Corp.'s Wichita, Kan., plant and are welded shut before shipment.

Twenty-one storage capability is a requirement for the system.

KD2B-1 is planned for installation on 11 different types of aircraft utilizing the same launcher. Standard adapters will be used for mounting the target to support points on wings or nacelles of different aircraft. Navy plans to use it with McDonnell F3 and F4 (F4H), Douglas A-4 (A4H) and F-5 (F5H), Chance Vought F-6 (F6H), North American F-4 (F4H) and Grumman F-11 (F11H). Air Force version, designated Q-12, is planned for McDonnell F-101, Martin B-57 and Convair F-102 and F-106 variants.

Qualification missions included 35 test flights of the KD2B-1, of which 30 were tested successfully. Halfway accompanying with original half-price orders was evaluation in service to full-price contract orders.

The reliability of the decentralized control system was also indicated during the flight tests.



Twin installation of Beech KD2B-1 target system is shown on Chance Vought F-6H carrier aircraft. Aircraft is fitted with external stores racks for fuelpots and zero velocity. KD2B-1 carries carbide, tests included storage, including from magazine, checkout, aircraft installation and launch with aircraft from the carrier catapult, in addition to fuel catapult tests and arrested landings.



KD2B-1 is moved into position, left, and attached, right, to LAU-3MA launcher system to target extended below wing rails of F3.



KD2B-1 is spread from F-3 wing rack, left, during test flight, right, of 160 mi. After launch at 35,000 ft., target climbed to 70,000 ft.







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electrons were deployed beyond their last landing edge opened their wingtips a few inches back on the right horizontal stabilizer which also failed forward. To the leftward 11 ft of the right horizontal stabilizer and elevator were in the process of separation they released the structure of the remaining forward stabilizer section, which subsequently separated prior to impact. This sequence rendered the aircraft uncontrollable.

### Bird Strike Problem

Collins radio built has of course been a problem for many years, but during war-time it became acute it was probably one of the worst. The speed of radio interference was such that changes were made. This time speed was needed in the case of aircraft and other aircraft. The fact that aircraft were in the process of separation and that some degree of control was possible from them became a very serious matter that required a great deal of calculation—the mathematics and following several years of study and testing, significant progress was made to require a minimum of protection through the use of unpowered stabilizers.

One of the more serious strikes was conducted by the Civil Aeronautics Administration in the early 1942 and 1946 during which time bird strike data were collected, collated and analyzed. This collating report showed that of all bird strikes to all types of aircraft, 33% were to windshields and that of the strikes resulting in damage checked in some windshields were involved in 75% of the cases. The reports further produced some additional figures which indicated that strikes

to other parts of the aircraft did not pose a serious hazard.

Strike Area	Percent of Total Strikes
Wingtip	11
Forward	19
Wings	23
Other	4

and aircraft landing gear, and engines.

In consideration of the fact that aircraft damage to such items is serious, and that birds do not fly themselves under an aircraft except in the latter flight the industry was probably satisfied at that time that further "birdproofing" requirements were unnecessary. This is not to imply that progress was made, for certainly the industry has made considerable progress in the area of aircraft design and in the area of aircraft performance and in the area of aircraft safety, but following the warbird program there was no industry-wide concerted effort toward further "birdproofing," nor was there any reduction of its severity.

### Report Concludes

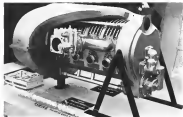
The industry report, written in 1948, continued among its conclusions was which contained valid for many years.

No recent study of any kind in the United States could be obtained of aircraft bird strikes.

The industry study with the crash of a Lockheed L-1049 at Boston, Massachusetts, on Oct. 8, 1963. This accident clearly demonstrated that even small birds, if in sufficient numbers, could penetrate a class of aircraft which could render a modern aircraft uncontrollable.

A series of tests and studies were run

to determine if birds could penetrate a class of aircraft which could render a modern aircraft uncontrollable.



Curtiss-Wright Displays Rotating Engine

Curtiss-Wright EC460 rotating combustion engine shown here in workshop form, is one of several versions of the new Hawk powerplant now being prepared to deliver 1400 and 1600 horsepower. Engines are built at four 600 cc, in each designed to produce 1400 hp at 6000 rpm. Powerplant is assembled and runs a complete test in house making the entire development cycle of the engine. Dry weight is classified at 525 lb. Two stroke and greater fuel with reduction giving economies in fuel. Propeller tip speed approximately 1,000 fpm. Overall length is 41.5 in., width is 23.0 in. and height is 26.5 in.



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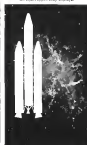
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## WHO'S WHERE

(Continued from page 71)

### Honors and Elections

Richard A. O'Connor, chief board chair man of The Magazine Co. has received The Outstanding Public Service Award from the U. S. Navy in recognition for his outstanding contributions to the Navy in the field of aerospace technology.

Dr. Marvin Ashton has been named by the National Academy of Sciences-National Research Council as executive director of a research to direct a study of the relation of the nation's scientific and engineering manpower. Dr. Ashton is to have been Science Development Corp. where he is a principal scientist.

Thos. Graves, senior photographer at Ranch & Look Inc. has received the 1968 annual Photogrammetric Award of the American Society of Photogrammetry in recognition of his developing efforts which provided the mapping industry with an instrument for utilization of 100-amp. photography.

### Changes

Dr. Thomas O. Pickett, manager of Civil and Electric Co. & Lockheed Martin, has been appointed (TENTATIVE) Santa Barbara, Calif. TENCPO will expand its activities to provide advanced planning services to U.S. Army, Air Force and Defense Group.

North America Aviation's Columbia (KOH) Div. has announced the following appointments in Seattle: Fred Electronic Systems; Dr. J. R. Hensley, chief scientist Applied Research; Richard Holden, manager; Nancy Anderson, LA-1A Weapons manager; Conrad and Conrad Systems.

Don E. Hoots, director of public relations, Aerojet Div., Douglas Aerojet Co., Long Beach, Calif.; Ron Gabbard, director of financial management, Douglas Missile & Space Systems Div., Santa Monica, Calif.; Eugene Tschoban, assistant director; Frederick V. Schaefer, Systems Research and Planning Div.; Aerospace Corp., Los Angeles, Calif.; and Charles H. Kelley, systems manager, Javelin Supplemental Office.

Charles D. Boudinotte, director of technical sales, Van Gorp Aerojet Supply, with offices in St. Louis, Mo.

William W. Gray, corporate director with Irving and Gresham affiliated sales, United Electronics, Inc., Pasadena, Calif.

Col. Jack T. Butler (USAF) will be part director, Aerospace Industries Assn., Washington, D. C.

Clyde K. Beckstead, operations manager, Republic Co.'s manufacturing facility, Mountain View, Calif.

William H. Dandorf, general manager Pacific Optical Div., Chance Aircraft Sales, Inc., Inglewood, Calif.

James K. Fackler, military systems sales manager, Western Instruments and Electronic Div., Dynamics, Inc., Newport, N. J.

Capt. Thomas Olsen, president of Eastern Air Lines, Inc.

David S. LeVine, assistant general sales agency, Lockheed Martin Denver (Calif.) Div., Martin Marietta Corp., Greenwood Village, Colorado (VW Feb 25, p. 37)

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### Chief of Weights Engineering

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## LETTERS

## Microelectronics

I read with considerable interest Terry Miller's article on macrodromones (JW Feb 25, p. 88). I consider it a timely and excellent article.

Although I have not yet seen the Author's Little report, I believe that forecasts, as summarized by Mr. Miller, are probably somewhat conservative. I suspect that estimates of \$400 million in FY-1 may be low by at least a factor of two.

I also do not fully agree with the statement that the segment of microelectronics on the future electronics industry during the next decade will be less than that created by the introduction of transistors during the 1955-1960 period. My perception is that it will be much greater.

J. M. Benson  
Deputy Office of Electronics  
Office of the Director of Defense  
Research and Engineering, OSD  
Washington, D. C.

### Variable Sweeping

Your editorial "NASA Needs a Watch Dog" (NIE Feb. 15, p. 21) shows our incredible regard for the taxpayer's wallet: but wastes one significant point. While the space intentions of this agency consume most vegetables than anything not on the defense budget lets not overlook the agricultural search, hitherto known as NASA.

The TFX contract, long delayed and currently under investigation, followed a scientific briefthrough claimed by NASA and posted by Victor Air Command. Actually, the idea of variable wing shape, a simple past post came from James Allen in England. However, the British, with demonstrative weakness, have decided they will not be enough money after having spent the money it takes to pass the principle, then British-style incremental machine, which in purpose to TFX, is said to simplify

Much has been made of the political influence believed to be at work behind the TYN contract award, but very little has been said about the technical shortcomings involved. While a recent study of "senior" projects upon discussion of its issues at NASA's School of Senior Fellows, their "pool" of candidate seniority is about as random as that offered in television commercial for toothpaste, research, defense, medicine, and the like.

Following our meeting and on the one day before TPA's proposal, I knew that a sensible road design was submitted but I was not clearly satisfied that any other kind would be ignored. No discussion and no criticism of the official layout had been presented, but no responsible engineers' input is provided. I considered that a fully sound design had been made for a sensible price. Certainly NAA's approach appeared to be inadequate to an extent we agreed. By taking liberties with the proportions of the models and manipulating cynically for cost effect, they can do very be made to look better than they are.

and, vice, whether the bars in  $\mathcal{N}(\mathcal{M}, \mathcal{A})$

*Archives Week* welcomes the opinions of its readers on the issues raised in its magazine's editorial columns. Address letters to the Editor, *Archives Week*, 335 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of letters will be withheld on request.

published rubric is deliberate or simply the result of ignorance in that agency the Defense Dept.'s irresponsibility in publishing an estimated \$5 billion on such a flimsy breakthrough is astounding. The most anyone could reasonably justify making an idea like this the cost of one or two prototypes. The money so far wanted by NASA and military, would have paid the at least one of them. As Adam Heywood has successfully put it: "There's plenty of evidence to indicate that an eye can pick a winner in the proposal stage."

Mr. Oberlin's proposal I know was "top technical." That is, we talked about what was technically "sound." The "technical" and "sound" would do the trick. When we got back to the "admiral" in the state of the art, we produced the bizarre results we saw. The "admiral" was not to be discarded in deeper contemplation; the frequency must be treated to a combination of the whole thing before it's built. It's essential to have a "top technical" approach to the parameters in as down the drain. (Remember the F-105? the X-15? the SR-71?)

As a result, in all of our "top technical" proposals, we have been "top technical" in our "technical" sense of its meaning. SR-71? or SR-72? or SR-73? or SR-74? or SR-75? or SR-76? or SR-77? or SR-78? or SR-79? or SR-80? or SR-81? or SR-82? or SR-83? or SR-84? or SR-85? or SR-86? or SR-87? or SR-88? or SR-89? or SR-90? or SR-91? or SR-92? or SR-93? or SR-94? or SR-95? or SR-96? or SR-97? or SR-98? or SR-99? or SR-100? or SR-101? or SR-102? or SR-103? or SR-104? or SR-105? or SR-106? or SR-107? or SR-108? or SR-109? or SR-110? or SR-111? or SR-112? or SR-113? or SR-114? or SR-115? or SR-116? or SR-117? or SR-118? or SR-119? or SR-120? or SR-121? or SR-122? or SR-123? or SR-124? or SR-125? or SR-126? or SR-127? or SR-128? or SR-129? or SR-130? or SR-131? or SR-132? or SR-133? or SR-134? or SR-135? or SR-136? or SR-137? or SR-138? or SR-139? or SR-140? or SR-141? or SR-142? or SR-143? or SR-144? or SR-145? or SR-146? or SR-147? or SR-148? or SR-149? or SR-150? or SR-151? or SR-152? or SR-153? or SR-154? or SR-155? or SR-156? or SR-157? or SR-158? or SR-159? or SR-160? or SR-161? or SR-162? or SR-163? or SR-164? 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This letter expresses an officer's disapproved but generally popular view. It is disapproved, but in that sense of industry I hope will meet. It's about his some disarming opinion to be revealed.

(Name withheld by request.)

California Business

### Design Concept Level

Subject: *Value Analysis* (AM Feb 73, p. 124).

1. L. Dorn of the Marine Defense Value Analysis Staff agrees with me when he writes that "almost all product costs and problems are created during design." However, he goes on to say when he states that "there are cost reductions more often and above those achieved at the design concept stage, which are usually more difficult to measure, and very often unnoticed."

The cost savings at a dense coastal

level not only are not difficult to measure but they have been thoroughly verified. The automotive industry keeps very tight track of such costs. For under a thousand cars, all production is world renowned. Even, McMillan's trustee Doug Coo

On the main subjects covered in Mr. McNelly's book are such cost comparisons as leased assembly vs. investment tooling, purchased part vs. investment tooling, per manual mold vs. die casting, fittings vs. molded form, valve tolerance keeping vs. forged before finished turbine costs. The list is almost endless.

Another subject Mr. Davis would enjoy is the cost/straight line expense ratio, the most commonly used method of allocating manufacturing costs. That came up and resulted in a design in mass lower per piece of airplane manufactured from steel \$1.5, about 15 lb./[PPAM] to cost \$700. 1.5 lb./[PPAM] (a 90% reduction in labor cost to the original cost) plus (subject to Boeing Member) The Boeing Co. has used Waddi War 2 on the 8.29 model base checking cost reduction in design, tooling and manufacturing costs. Series of data on that subject are available.

Having read of Burns's recent experience on the TPN competition, I would certainly not recommend his practice to other aerospace contractors. **Dr. E. McDONALD**  
Los Angeles, Calif.

### "Second-Class Citizens"

Success: I have noted that the paradigm of two representations and the term "mixed class classes" is a subtle statement.

The first time I noticed this firm was in a United Air Lines newspaper advertisement regarding their one class for plus-in's, (all coach passengers compensated for) Mile Second Class, where they board a coach section. The second time was in the article concerning the purchase of EAC 181 jets by Midwest Airlines in the May 4 issue of Aviation Week & Space Technology. (p. 46) Mr. French said, "You can't understand how boring the second class seems."

This seems to be, in my opinion, typical of white people thinking in general. The message will either leave a numbness or, in certain examples, of the days and recover rapid action. In other words if I can't afford a Cadillac I am not fit to be a citizen of the United States.

The sailors seem to have lost sight of the fact that they are as business as possible transportation, and to provide transportation that is within the reach of as many people as possible.

Profoundly I believe traveling by air is the only way to travel, however, has this allowed to take me barely on a two-week vacation in the East or Midwest? Even at present crash fares, the air fare would be equal to a month and one-half out wages.

D | SEVENTHGRADER  
Drew Robins, Calif.



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X takes off straight up—speeds along to its destination and lands vertically. Bell originated this revolutionary V-STOL, a new building it for the U.S. Navy. Designed the X-22A, this compact, high-performance research transport will have speed up to 350 mph, will be capable of carrying six passengers or a 3000-pound load with full fuel. The jet-powered, ducted fan, rotatable propeller units make this craft completely independent of runways—a capability that will open the door to many new military and commercial applications.

is a 900-seater that has unique concept originated Bell, because Bell created and built the X-14 for the U.S. Air Force – the first jet-powered horizontal-stance VTOL craft to take off vertically, transition to normal horizontal flight and then hover and land vertically. A modified version, the X-14A, serves NASA's Ames Research Center today as a lunar landing training vehicle... has interesting possibilities as a ground support aircraft... is the only two-place jet VTOL aircraft ever flown anywhere in the world.



4. The author is not a member of the American Psychological Association.

# ORBITAL REENTRY

Spacecraft programs, each engineered to explore diverse techniques for earth orbital reentry, are underway at McDonnell.

MERCURY



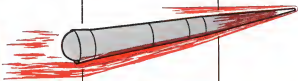
MERCURY, America's first manned orbital spacecraft, utilizes a non-maneuverable ballistic reentry. After retro-rockets slow the spacecraft to bring it out of orbit, reaction jets position it for reentry. Mercury's ballistic shape maintains alignment with the drag vector as it follows a ballistic path through the atmosphere to drogue chute deployment at 21,000 feet. Final descent to an ocean landing is accomplished with a 63-foot ring-sail parachute.

ASSET



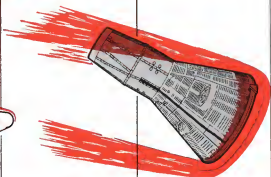
ASSET, an instrumented, unmanned, winged vehicle, will reach speeds of 13,000 miles per hour in sub-orbital flights at altitudes of over 40 miles. This space research program will provide for study of glide reentry technology, refractory materials fabrication experience, and accelerate the development of maneuverable reentry techniques. A parachute landing system enables recovery of vehicle and data package for post flight analysis of test data.

AEROBALLISTIC



AEROBALLISTIC is a word coined to describe the lifting body concepts proven by flights of McDonnell hypersonic missiles from Cape Canaveral in early 1959. The test flights demonstrated precise atmospheric control, the aerodynamic efficiency of an Aeroballistic vehicle and were the first breakthroughs in the design of maneuverable reentry spacecraft. Space missions utilizing an Aeroballistic type vehicle would terminate with a conventional runway landing.

GEMINI



GEMINI is a two-man orbital spacecraft for long duration and rendezvous missions. Upon reentry, the crew will position Gemini's off-set center of gravity with attitude control jets to re-orient the drag vector and create a lift component. This lift will enable the crew to maneuver Gemini to any point in a 28,000 square mile landing area. A paraglider will be deployed in later flights, enabling precise astronaut control of the glide to the landing field.

With MERCURY, ASSET, AEROBALLISTIC and GEMINI Spacecraft, McDonnell is perfecting reentry techniques, shapes, materials and manufacturing processes necessary for the achievement of U. S. leadership in space.

## MCDONNELL



• Mercury and Gemini are being designed and built by McDonnell for NASA under the technical direction of the Manned Spacecraft Center.

• ASSET is being developed and built under the sponsorship of the Aeronautical Systems Division of the Air Force Systems Command.

• Aeroballistic vehicles were developed and tested under contract with the U.S.A.F. and development is continuing with company funding.